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BREEDING TIMOTHY AT SVALÖF

THE GENIUS OF THEODORE ROOSEVELT

A DEFECT OF HAIR AND TEETH IN CATTLE

A NEW SOURCE OF PLANT FOOD

INHERITANCE OF COAT COLOR IN GREAT DANES

OLNEYA BEANS

ORGAN OF THE

AMERICAN·GENETIC·ASSOCIATION

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"An exact determination of the laws of heredity," says William Bateson, "will probably work more change in man's outlook on the world, and in his power over nature, than any other advance in natural knowledge that can be clearly foreseen."

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NOTE

Instead of raising the price of membership, and in order to meet the requirements of the War Industries Board, and also because of the drafting of the whole Editorial Staff the July, August and September numbers have been dropped out for 1918 and 1919. Vol. IX contains only 8 instead of 12 numbers, as will also Vol. X.

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Date of issue of this number, October 15, 1919.

DIFFERENT FORMS OF TIMOTHY

The *aftergrowth* or development of the plants after cutting is shown by these four clumps, which were cut on June 28 and photographed September 2. "The quantity of the aftergrowth is to a large extent due to more or less favorable conditions of weather, but also to different forms. Some forms yield exclusively leaves, others leaves and stems, and others again nothing but single stems." The tall plant on the left is referred to in the text as *a*, the one next to it *b*. (Frontispiece.)

BREEDING TIMOTHY AT SVALÖF

HERNFRID WITTE

Director of the Forage Plant Section of the Swedish Seed Association

MY INTENTION in presenting the following report is to give a short account of the methods of timothy breeding at Svalöf, the multifariousness of forms studied, and the results gained from this branch of breeding up to the present time.

The Meadow culture in Sweden is of high importance, about one-third of the open area being occupied by meadows, most of which are temporary. Sweden's annual want of clover and grass seed amounts to about 11 millions of kilograms, of which not less than 4.8 millions is Timothy seed. In the year 1907, when grass breeding work was taken up at Svalöf, timothy was the first to be made an object of investigation; but also orchard grass (*Dactylis glomerata*), meadow fescue (*Festuca pratensis*), tall oat grass (*Avena elatior*), perennial ryegrass (*Lolium perenne*), field bromegrass (*Bromus arvensis*) and several others were added.

THEORY AND METHODS OF BREEDING TIMOTHY

Timothy normally being cross-pollinating and exhibiting manifold variations in nearly all its characters, appears in an infinite number of different forms, though only a very few of them are fully constant, giving a uniform progeny after self-fertilization. Suppose, for instance, that twenty-five different pairs of characters (surely a far too low number) are represented in timothy, this certainly means that $(2)^{25}$ or 33 million constant combinations may exist, but the number of possible combinations, amounting to $(2^{25})^2$ or about 1.126 milliards, means only one perfectly constant individual in 33 millions. It is therefore practically impossible to base timothy breeding on selection of constant individuals. Instead one has to select a great number of individuals, to study the practical value of the progeny of each of them—if possible, in several generations. It may be necessary to repeat the selection before at last introducing to agriculture the variety or varieties that have proven to be of the highest practical value.

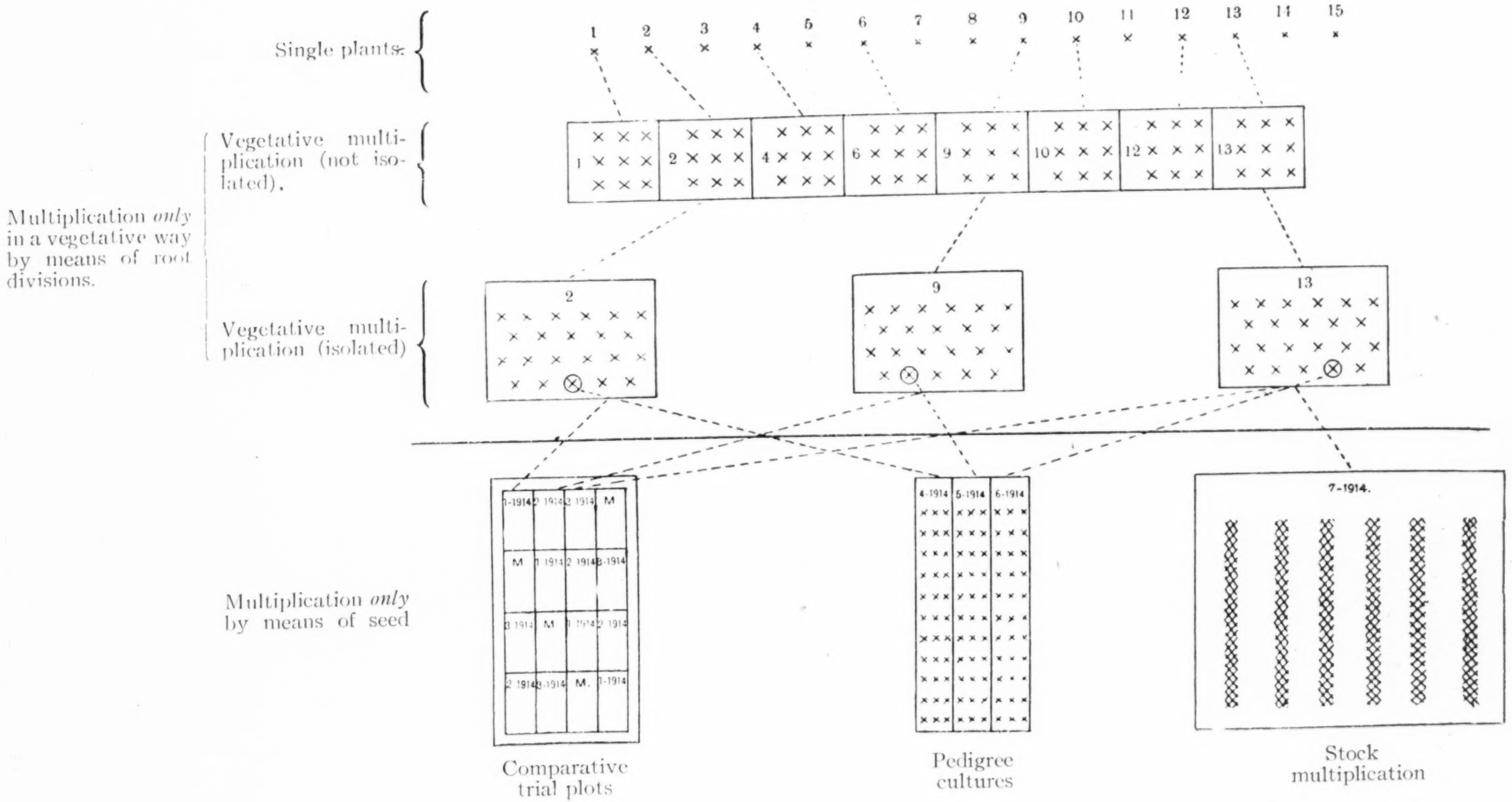
The practical method used at Svalöf in breeding perennial grasses appears from the following scheme. From nature, or from cultures at Svalöf, pedigreed plants are selected and vegetatively multiplied in plots for the purpose of attaining the truest possible estimate of different characters desired. The best of these plots are then reincreased vegetatively into larger plots, situated as solitarily as possible. This is marked on the chart "vegetative multiplication isolated." With seeds from the last-mentioned plots comparative trial plots are laid out, and when in several trials a sort has proven practically superior to the very best commercial seed, and also has afforded evidence of practical uniformity, it may be multiplied and distributed on a large scale. Uniformity is studied in special pedigree plots where the plants, raised from seeds obtained in artificial isolation, are growing in like distances each way, generally 40 cm. In these pedigree trials new selections are made—individual as well as mass selections.

VARIATION AND HEREDITY OF DIFFERENT CHARACTERS

The length of stem varies remarkably, from 20 to 30 cm. on the one hand to 110 to 120 cm. on the other (see Figs. 1 and 5), and displays a series of hereditary gradations, though at times it may be difficult distinctly to state the hereditariness of the separate gradations, since modifications from the environment are rather considerable.

TWO EXTREMES IN HABIT OF GROWTH

These plants illustrate the remarkably wide range of variation which occurs among timothy plants in habit of growth. (Fig. 1.)


Single plants
Vegetative multiplication (not isolated).
Multiplication *only* in a vegetative way by means of root divisions.
Vegetative multiplication (isolated)
Multiplication *only* by means of seed
Comparative trial plots
Pedigree cultures
Stock multiplication
7-1914.

Number and Length of Internodes.—As a rule most types possess 6 or 7 internodes, seldom 5. Concerning the length of the different internodes the top internode is always the longest. The length decreases downward, so that the base internode normally is the shortest.

Comparing different forms, the lengths of the internodes vary, absolutely speaking, to a considerable extent, a fact that causes the various length of stem in various forms. Not only absolutely but also relatively considered, the length of the internodes is varying to the extent that the relation between the different internodes in this respect is rather different in different forms. The top internode may, for instance, in some forms be longer than half the stem's length, whereas in others it hardly equals one-fourth of the whole length. The base internodes are in certain cases very short, in others rather long (see Fig. 3). In this respect the modifications are remarkable, but regarding the length of the internodes there exists, no doubt, a wide range of hereditary gradations.

Thickness of Stem.—As a matter of course there generally exists between tall and short stem-forms rather great differences in thickness, a fact, however, that also may be noticed between forms of about the same height, so that length and thickness of stem are not always correlated. The thickness of stem is naturally an hereditary character.

Direction of Stem.—In most timothy forms the stems are stiffly erect, in some, however—for instance, in several dwarfed varieties—they are more or less spreading, but mostly they have a comparatively irregular direction, varying from erect to spreading or at least a tendency towards spreading (see Figs. 1 and 5). In other varieties the stems are decidedly spreading, sometimes making an angle of only 30 degrees with the horizontal level (Fig. 1*b*). Direction of stem is an hereditary character and has a practical bearing.

Size and Color of Leaves.—In width and length as well as in their mutual relations the leaves vary considerably. The middle leaves, which are the largest, may in different forms vary in width from 4.6 to 10.6 mm. and in length from 55 to 276 mm. The relation between width and length of leaves is subject to a wide range of variation; the length of the middle leaves varies in different forms from 14 to 40 times the width. Thus there exist many combinations of gradations that certainly are hereditary, though it is very difficult to arrive at a definite conclusion in this respect. The leaves may also be flat or more or less boat-shaped.

As to direction of leaves, in most forms the leaves are drooping, in some nearly erect. The color of the leaves varies from pale green to dark or bluish-green. The stems are normally yellow-greenish; at times the upper internodes may be rather intensely anthocyan or bluish colored.

Variation of Head.—The head is subject to marked variations in length, thickness, shape, stiffness, compactness, etc. (see Fig. 3). Length and thickness of the head change markedly. No correlation exists between these characters, as in two variations of like length of head the thickness may differentiate considerably, and vice versa. It may be stated that the length of head varies from 2 to 15 cm. and the thickness from about 3 or 4 mm. to 8 or 10 mm. Different gradations of size of head are obviously hereditary. The shape of head is normally cylindrical, occasionally with tapering apex or base, rarely fusiform, all of these characters being surely hereditary. As a rule the head is stiff, occasionally slender and nodding.

In the typical timothy head the rachillae are reduced to such an extent as to give the 1-flowered spikelets the appearance of growing out directly from the spike axis; in exceptional cases the rachillae are elongated, making the spike more panicle-shaped. Also these characters are hereditary (see Fig. 3).

Variation in Flower Parts.—The empty glumes vary in size from 2.5 or 3 mm. to 5 or 5.5 mm. in length (see frontispiece *a*, *b*) as well as in color at

GLUMES AND SEEDS

A detailed representation of the variations which occur in the glumes and seeds of timothy. *A* and *b* are empty glumes; *c* to *h* floral glumes, and *i* to *m* seeds of different forms. *A*, magnified several diameters. (Fig. 2.)

VARIATION IN TIMOTHY HEADS

This series of heads represents the range of variation which has been obtained during the course of the breeding work at Svalöf. "The length of head varies from 2 to 15 cm., and the thickness from about 3 or 4 mm. to 8 or 10 mm. Different gradations of size of head are obviously hereditary." (Fig. 3.)

bloom and maturity. The floral glumes are also subject to variability as to form, size and color. Normally the first floral glume is awnless, occasionally having a small awn (see Fig. 2, *c–h*). The anthers vary in color from white to intense violet, sometimes rust-brownish. The grains present variations in form (roundish or pointed), color (light to dark brown) and size (see Fig. 2, *i-m*).

Physiological Characters.—Regarding hardiness no difference between various forms has been noticed at Svalöf, but in the northern part of Sweden, at the branch station of the Swedish Seed Association at Lulea, Lat. 65° 35′ N., marked variations in this respect have been noted.

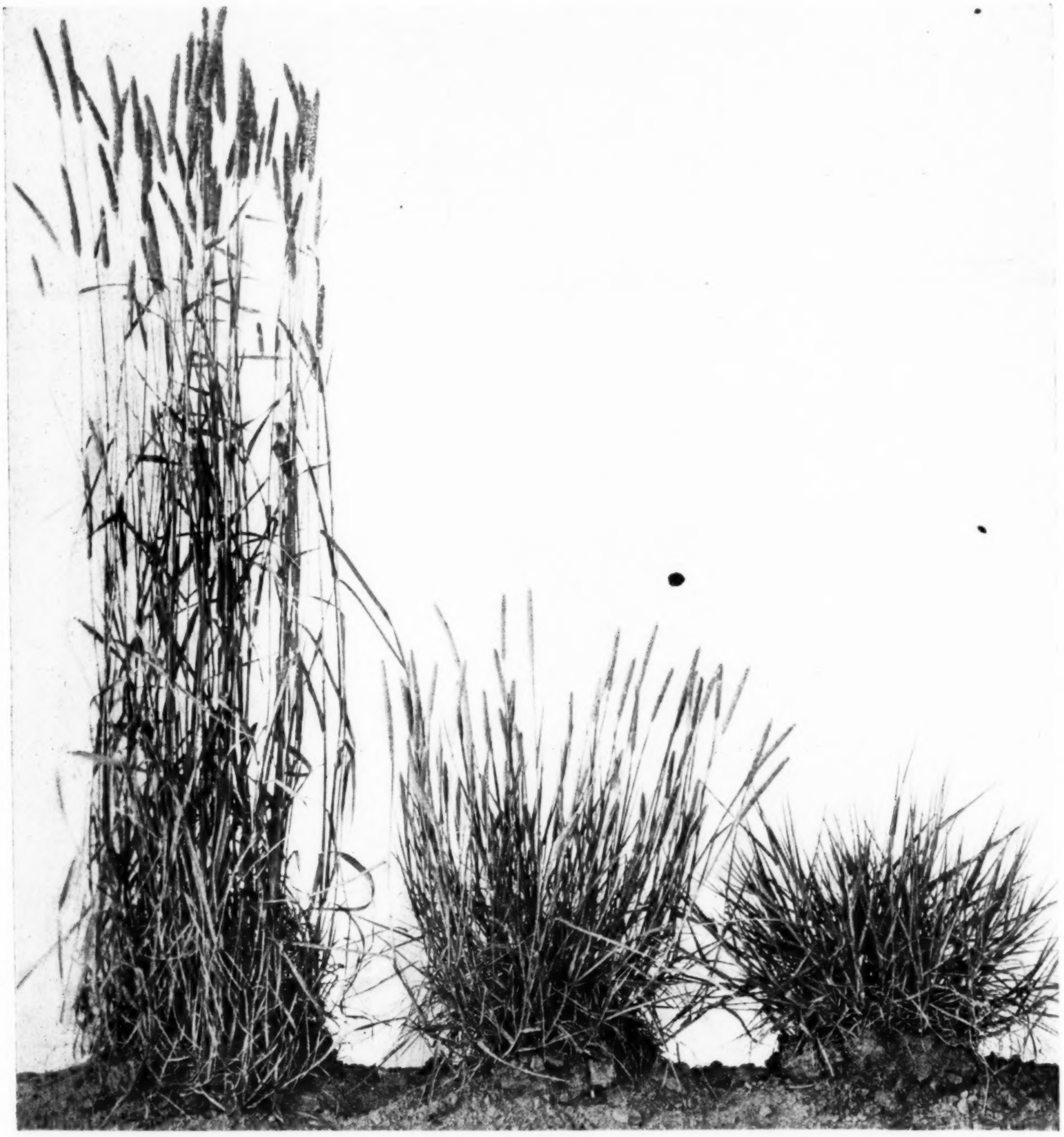
Different timothy forms present a noticeable variation in earliness of shooting culms in spring time as well as in earliness of bloom (see Fig. 5). The beginning of the bloom time may differ with twenty-five days between the earliest and the latest forms. These characters are anyway not correlated, but hereditary. Stiffness of stem appears to vary as in the cereals and is also hereditary. Withering down of leaves is an hereditary character that may be very pronounced. In some forms all the leaves may be withered at the beginning of the bloom; in others they may be almost fresh even at the ripening of the seeds.

Aftergrowth.—The quantity of the aftergrowth is to a large extent due to more or less favorable conditions of weather, but also to different forms. Some forms yield exclusively leaves, others leaves and stems, and others again nothing but single stems (see frontispiece). As to stooling power there is a wide range of variation in different forms.

Disease Resistance.—The resistance against the timothy rust (*Puccinia phleipratensis*), the fungous disease that most severely attacks timothy, varies considerably in different forms. Some forms are so intensely affected that rust appears even in the empty glumes,

DIFFERENCE IN RUST-RESISTANCE

These two plants were photographed in the spring of the year. The one on the left was not affected by timothy rust the previous season, while the one on the right was seriously affected. Variations in resistance to rust are inherited. (Fig. 4.)



THREE DISTINCT STRAINS

The plant on the left represents a tall and early-maturing strain of timothy produced at Svalöf; the one in the center is medium-sized and moderately early; and the one on the right is medium-sized and very late. (Fig. 5.)

whereas other forms growing close by may be left nearly intact. The practical importance of this hereditary character should not be overlooked, as severely diseased individuals evidently decrease in yield the following year (see Fig. 4), or occasionally even are killed out by the attacks. There are also other fungous timothy diseases as, for example, *Scolecotrichum graminis*, *Epichloe typhina* and *Dilophia graminis*, but the power of resistance against these diseases has as yet not been a subject of investigation.

Resistance to aridity also displays variations, some dwarfed forms with reduced transpiration surfaces being more suitable for adaptation to dry conditions.

Specific longevity is no doubt in-

herently varying in different forms, though it is difficult to make an exact statement on account of the variability in external conditions.

WHICH CHARACTERS ARE MOST DESIRABLE?

Evidently all characters in timothy are more or less subject to variation, but all gradations of characters are combined in nearly infinite numbers of different forms. Most of these are hybrids, at self-fertilization yielding an offspring more or less uniform, splitting up in different types. To produce perfectly constant timothy sorts is practically impossible. Breeding work, therefore, demands that one should chiefly eliminate characters of a purely theoretical interest and endeavor to gain the highest possible uniformity concerning practical characters.

A timothy sort for ordinary 2-years lay should possess:

1. Tall, not too stout, erect, comparatively stiff stems with short top internodes and relatively long base internodes.
2. Vigorous, abundant stooling power.
3. Profusion of leaves, perfectly fresh at cutting.
4. Rich aftergrowth.
5. Satisfying hardiness.
6. Highest possible resistance against rust.
7. Convenient earliness.
8. Good development during the second yielding year.

A timothy sort for perennial pasture should possess:

1. Vigorous stooling power.
2. Early and abundant aftergrowth after each grazing.
3. Satisfying hardiness.
4. Highest possible resistance to rust.
5. Highly increased longevity.

As a matter of course a high yield of hay is the chief goal in timothy breeding, but the importance of combining a good seed production must not be overlooked. For this purpose the following characters are requisite: First, tall, stiff, compact, uninterrupted heads; second, big, plump, well-colored seeds, easily loosening from empty glumes and with well-fastened floral glumes; and third, high ability of self-fertilization.

ACTUAL PRACTICAL RESULTS AT SVALÖF

After the year of 1909 comparison trials have been made with manifold sorts selected at Svalöf, but space is too limited for an account thereof. On a basis of the above trials the two following new sorts have been raised, introduced, and distributed, namely, Primus timothy and Gloria timothy. These sorts have in trials at Svalöf afforded respectively 12 and 20% higher yield than ordinary Swedish market seed, thus indicating a marked progress. The above sorts are resistnat to rust and are high yielders of seed.

YIELD OF DIFFERENT TIMOTHY SORTS IN TRIALS AT SVALÖF, 1909–1918

	Kilograms of green fodder per hectare			
	First year's lay	Second year's lay	Total	Yield % compared to ordinary Swedish timothy
Svalöf's Gloria timothy	14.480	11.030	25.510	120.6
Svalöf's Primus timothy	13.460	10.210	23.670	111.9
Ordinary Swedish timothy	11.570	9.590	21.160	100.0

GENIUS OF THEODORE ROOSEVELT AND HIS PLACE AMONG HISTORIC PERSONALITIES

FREDERICK ADAMS WOODS
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NOW that Theodore Roosevelt has passed away, the whole world is ready to acclaim what only a small faction formerly perceived, that this extraordinary man was not only one of the greatest of all Americans, but was in his characteristics and conduct essentially a man of genius.

The general unwillingness or inability to justly estimate our former national leader arose from several causes by no means unique in his case, but rather the exemplification of the eternal relation of the man of genius to the men whom he seeks to persuade.

If the pioneer is a man of science or an artist, he has his small group of doubting professional colleagues who need to be shown the way. If the artist or scientist has found a new truth, it is not usually long before this is accepted. Such men, if they be really great and live to a ripe old age, are almost sure to receive phenomenal recognition before they die. Names swell into memory to support such a view: Newton, Boyle, Darwin, Lister, Kelvin, Ramsay, Franklin, Rumford, Pasteur, Cuvier, Fabre, Linnaeus, Lagrange, Laplace, Tycho Brahe. Goethe, Kant, Helmholtz and Faraday, Titian, Michael Angelo, Raphael, Leonardo, Rubens, Van Dyke, Holbein, Durer, Millet, Corot, Whistler, Hogarth, Reynolds and many others, all received, if not ample, at least very distinguished recognition during their actual lives. There are exceptions. Copernicus was long unappreciated, Galileo had a hard time, and Mendel was unknown until years after his death. Manet, the founder of impressionism, was only in part appreciated. He died at the age of fifty—a recipient of the Legion of Honor. William Blake lived to be seventy, too long for his own happiness. He died in poverty and obscurity. There have been other martyrs to science and art. It is perhaps the popular conception of the typical man of genius that he is unrecognized in his day. But this is not the truth of the matter. It is like many other popular misconceptions, built upon the almost unavoidable tendency to note and remember the unusual and thus mistake the exception for the rule. Scientists, artists and musicians, even if bringing the best of news, all require time for its acceptance. The experts and the critics must be convinced; after that the public are easily made to follow on gregariously. There comes a day when opposition is negligible. Not so with the political genius. He always has to face a mighty opposition even to the day of his death. It lies in the nature of political and party bias and is inherent in the kind of work that is his. "A fight from start to finish," but there never is a finish, never was, nor can there conceivably be a finish, where the particular form of manifestation of genius is the leading of human groups. For there will always remain a very formidable aggregate of humans who, rightly or wrongly, even if it be a truth, cannot be made to see it that way.

It is essentially a different kind of problem, for here truth is not absolute and "right"—is always related to somebody's best interests. Even if it be made into the phrase, the "best interests of all," it will be impossible to bring all parties into agreement,

since the dispute will then arise as to the best methods of bringing about this desirable "best interests of all." The "politician" in life may in death become the "statesman," but his theories and his weaknesses are always more exposed to searching criticism than is the case in other forms of genius.

In the light of these considerations, and measured in comparison with other great men, the faults, inconsistencies, or weaknesses of Theodore Roosevelt appear inconsiderable, while the astonishing and versatile attainments place him easily among the first hundred and fifty of the world's most wonderful men. Take a'one the physical or (perhaps better) physio'ogical aspect of his personality. How seldom do we meet with people who have the constantly impelling vital force that Roosevelt had, who are always animated, always inspiring, always talking, or writing, or transforming thoughts into actions —always "feeling bully." If this sort of activity is, as modern physiology would lead us to believe, dependent upon an excessive amount of certain peculiar internal secretions, then, on the bodily side alone, Roosevelt must have been extraordinary. Although a man of action and known chiefly for his deeds and his relations with his fellow-men, the total output of his literary product, *i. e.*, his published work, exceeds that of any other Harvard man of his day.

Men of such constant exuberance of spirit, while rare, are not exceedingly uncommon. We all meet them from time to time, chiefly in the business world. They make good promoters. But do we often meet a man of that stamp who is also possessed of one of the most remarkable memories ever given to any human being? If we do, he is as one man in a million. There may be a hundred such persons in the United States today. But of these how many also are endowed with a high moral sense, with a never-failing desire to make the world over in the ways that seem for them unquestionably right? There are such men. History knows them. They are very few in number. They are famous. Some of them have been celebrated as preachers and reformers.

Now let these three traits, the first two of which are so rare, the third of which is not too common, be united with intellectual curiosity, leading to a variety of interests, which in time become coördinated into a broad outlook, and we have our rarer man still—one so rare that not a hundred and fifty men in all history outrank him in fame or eminence. And this is including all forms of activity—that of the painter, the poet, the preacher, the sculptor as well.

Gladstone may rank with Roosevelt or he may outrank him. Disraeli, Franklin, Pitt, Cromwell, Clive, William the Conqueror, Peter the Great, Pericles, Charlemagne and Julius Caesar may rank with Roosevelt. They may far outrank him. Doubtless some of them do. But the point is that there are so few of these very great names that before we reach the end of the first hundred and fifty we *willy-nilly* are obliged to include names that certainly do not suggest any more genius or any more greatness than that of Theodore Roosevelt. Let any reader try it for himself and get his friends to help. If he does not, before finishing his first hundred and fifty, then I wager that before finishing his second hundred, he will only be able to bring forward names of a somewhat secondary magnitude. The dazzle will be gone. At least Roosevelt will come in here somewhere.

In any estimate of genius it is well to have some objective standards of comparison and a list of names as inclusive as possible of all candidates for selection. Such a list can never be entirely satisfactory, but it is at least better than no list, since otherwise many suitable names would be overlooked. No list has been formulated attempting to grade great men according to their "pure genius," but there is a useful and suggestive list of "eminent" men based upon encyclopedias and biographical dictionaries. It was compiled by J. McKeen Cattell and published in *Popular Science*

Monthly, February, 1903. Here a thousand historical characters are graded according to their "eminence," in other words with reference to the amount of attention that they now attract. Such a method of comparison is obviously faulty as a test of mental merit, since it places Louis XVI, Philip II of Spain and George III of England in the first hundred. Also Nero, Robespierre, Mirabeau, and Bossuet seem out of place, nearly at the top of the heap. If we search down through the lower rankings we find some, though not proportionately many, of undoubted geniuses who ought to go higher up, such as Wagner, Copernicus, Kepler and Bach. Now if we substitute these for the misplaced names in the first hundred according to our choice, allowing for all differences of opinion, we do not change the character of the second hundred to any appreciable extent.[1]

The leading names of Americans are in order of eminence: Washington, Penn, Lincoln, Franklin, Jefferson, Grant, John Adams, Webster, Hamilton, Jackson, Longfellow, Prescott, Irving, Emerson, Madison, Farragut, J. Q. Adams, Hawthorne, Cooper, Rumford, Clay, Patrick Henry, Fulton, Sumner, Sheridan, Monroe and Audubon.

Washington, Penn, Lincoln, Franklin and Jefferson are in the first hundred, Grant, John Adams and Webster are in the second hundred, Alexander Hamilton and Andrew Jackson are in the third.

The place of Roosevelt in world history from the standpoint of genius seems to be, by this test, fairly well indicated. He certainly cannot go much below the second hundred, not if he be the equal of Hamilton or Jackson. If his genius were greater than that of John Adams or Webster or Grant, he may go in the first hundred; if greater than either Jefferson or Penn, then he might go well up in the first hundred. At any rate the probability is that there have not been more than one hundred and fifty men of eminence or of genius greater than Roosevelt in all recorded time.

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[1] My own suggestion is that the following names do not deserve a place in the first hundred. They should be placed somewhat lower, and room thus made for the names of very great men who have obviously been graded too low: Penn, Byron, Nero, Robespierre, Charles V of Germany, Mirabeau, Guizot, Bossuet, Thiers, Louis XIV, Fox, Machiavelli, Philip II of Spain, George III, Cousin, and Justinian. Some of these might be placed in the second hundred, some much lower. The second hundred might also be improved by the removal to lower grades of certain names as, for instance: Fénelon, Pius IX, Charles I of England, Lamartine, Joseph Bonaparte, James I, Alberoni, Louis XIII, Diderot, Marmont, Francis I, Nicholas I, Athanasius, Bentley, J. Cook, and Louis XV.

A DEFECT OF HAIR AND TEETH IN CATTLE—PROBABLY HEREDITARY[1]

LEON J. COLE
University of Wisconsin

IN THE spring of 1918 Prof. Arthur H. Kuhlman, of the State College, Brookings, S. D., at that time Agricultural Demonstration Agent at Juneau, Wis., brought to my attention an interesting case of dental deficiency in cattle. This was in a herd of purebred Holstein-Friesians near Juneau, and a short time later I was able to visit the place with Mr. Kuhlman and to secure some photographs and notes relating to the case. As the condition appears to be unusual, and as it shows evidence of being hereditary, it seems worth while to put it on record.

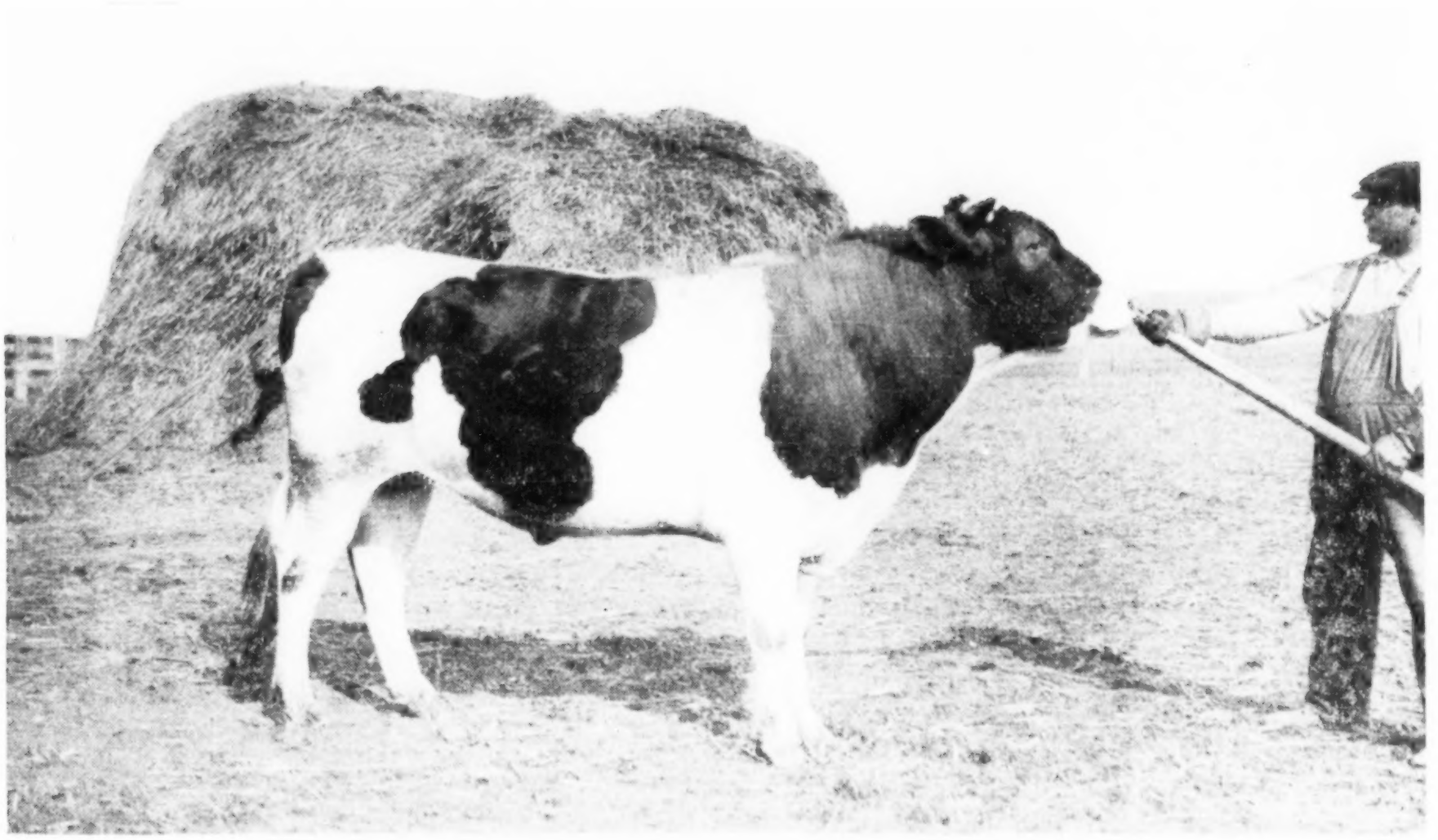
The defect was first noticed when some of the calves born early in 1918 were being taught to drink by putting the fingers in their mouths for them to suck. It was discovered in this way that three of them did not have well-formed teeth in front like normal calves. Furthermore, these same calves had a peculiar deficiency of hair, which will be mentioned more in detail later. The discovery of this condition in the calves recalled the fact that the bull which sired them had, when about a year old, been turned out on pasture with other cattle, and that he had grown thin while the others remained in good flesh. An examination was accordingly made of his mouth, leading to the discovery that instead of the normal complement of four well-formed incisor teeth on each side, in the front of the lower jaw, he had only three small, imperfect teeth on the left side and two correspondingly small ones on the right. These were so small as to be practically useless for cropping grass, which readily explained the bull's failure to do well on pasture. As may be seen, however, from Fig. 6, he was a well-developed, fine appearing animal. It was not practicable to secure a picture of his mouth showing the teeth.

This bull had been purchased of another breeder, and was coming three years of age at the time of our visit. Until his mouth was examined, it was not known that he was in any way imperfect or abnormal. The dams of the calves, so far as known, all had normal dentition.

Of the three defective calves of 1918, one had two small teeth on the left and one on the right, the second had one very small tooth on the left and one small one on the right, while the third (shown in Fig. 7) had two conical teeth on each side, the back ones being very small while those in front were larger but round and blunt. The contrast with the normal dentition in a calf of this age may be readily seen by comparing this figure with Fig. 8. Here the four sharp, well-developed teeth are plainly discernible.

Associated with the deficiency of teeth there was also a deficiency of hair. This was said to be quite noticeable in the very young calves, especially on the head and neck. The hair was not entirely lacking on these parts, but was very short, giving a semi-denuded appearance. Later in life the coat appears to be practically normal. At the age at which our photographs were taken the difference was easily noticeable, but it does not, unfortunately, stand out very clearly in the pictures. By careful scrutiny, however, it may be observed that the head and upper neck

[1]Papers from the Department of Genetics, Agricultural Experiment Station, University of Wisconsin, No. 19. Published with the approval of the Director of the Station.



ONE PARENT OF THE DEFECTIVE CALVES

This pure-bred Holstein-Friesian bull sired in two seasons five calves with defective coats. Three of them also possessed defective teeth. (Fig. 6.)

A PECULIAR DEFECT

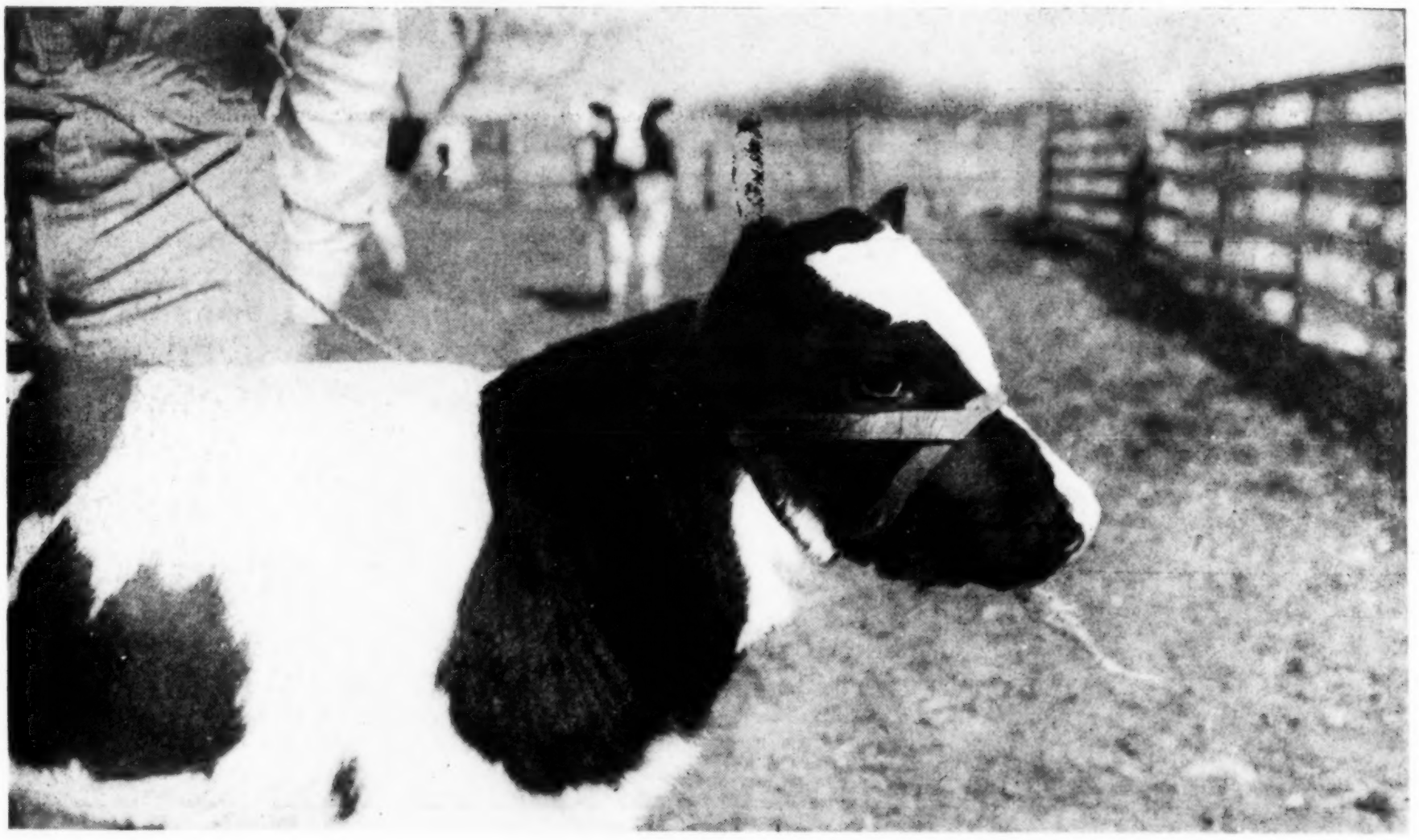
The calf whose mouth is here seen was sired by the Holstein-Friesian bull shown in Fig. 6. The incisor teeth, only two of which are to be found on each side, are conical and blunt. Compare them with the teeth shown in Fig. 8, which are those of a normal calf sired by the same bull. (Fig. 7.)

NORMAL DENTITION

This calf's teeth are normal, though it was sired by the same bull (see Fig. 6) as the calf with defective dentition shown in Fig. 7. There are four sharp, well-formed incisors on each side in the front of the lower jaw. (Fig. 8.)

A DEFECTIVE COAT

This calf is the same one whose mouth, with defective dentition, is shown in Fig. 7. The smoothness of the coat on the head and upper neck is due to the very short hair on these parts. This characteristic is probably correlated with defective dentition, and appears to be inherited. (Fig. 9.)



A NORMAL COAT

Head of the normal calf whose mouth is shown in Fig. 8, for comparison with the defective calf shown in Fig. 9. The contrasting length of the hair on the head is visible where it overlaps the halter strap behind the lower jaw. (Fig. 10.)

of the calf shown in Fig 9, the same animal as that in Fig. 7, is noticeably smoother than that of the calf in Fig. 10, the same individual used for comparison of the teeth in Fig. 8. Note, for example, how the hair at the angle of the lower jaw overlaps the halter strap in Fig. 10, showing that it is considerably longer than on the other calf. The coat also seemed thicker, but I cannot make a definite statement as to this.

Two calves born in the herd the previous year, and from this same sire, resembled the one described above in having a deficiency of hair, but no examination was made of their teeth, the correlation of the two at that time not being suspected. Whether the bull when young was similarly deficient in hair was not known.

To sum up, a purebred Holstein-Friesian sire with defective front teeth, bred to purebred Holstein-Friesian cows, produced in two successive years five calves with deficient coats, three of which are known to have had defective dentition corresponding to the condition of the sire. In the same season this bull sired some fifteen or twenty normal calves from dams in the same herd. There would appear to be a correlation between the condition of the coat and the deficient and defective teeth. Furthermore, since the bull was not born on the place, and all the calves, normal as well as defective, were reared under similar conditions, it seems probable that the condition is to be attributed to some genetic cause rather than to factors of the environment or to faulty nutrition. It is probably not comparable, for example, to hairlessness in new-born pigs, which is referable to thyroid conditions due to deficiencies in the diet of the sow. The question of the inheritance of the condition in the calves could not be carried further, as it was the intention of the breeder to eliminate all the defective stock from his herd.

A NEW SOURCE OF PLANT FOOD

"THE use of leguminous crops for soil improvement," writes Karl F. Kellerman, "has long been recognized by good farmers as desirable. Aside from the general benefits of crop rotation, the actual soil-enrichment is due largely to an accumulation of available nitrogen, and this gain in nitrogen is caused by the presence of minute soil-bacteria which possess the power of growing on the roots of the legumes and then utilizing or 'fixing' the free nitrogen of the air and converting it into food for succeeding crops."

North American farmers have become quite familiar with these nitrogen-gathering leguminous plants, and they play an important part in the cultivation of numerous crops. Cow-peas, velvet-beans, vetches, and other legumes are sown between rows of fruit trees and plowed under when they begin to bloom, in order that the nitrogen which they have gathered in the small nodules upon their roots may be utilized by the trees. The use of these green cover-crops lessens the amount of other fertilizer which it is necessary to apply to the orchard.

Attention has recently been called to certain plants which gather nitrogen, like the legumes, but which store it in small nodules on the leaves instead of on the roots. The one of which a leaf is shown in the accompanying illustration is *Psychotria bacteriophila;* it has been shown by Zimmermann and Faber that *Pavetta Zimmermanniana* and probably other rubiaceous plants have the same habit. These plants, which belong to the same family as coffee, are, like the latter, tropical in their distribution.

Faber has shown that these leaf-nodules contain colonies of a non-motile, nitrogen-fixing bacterium which he has named *Myco-bacterium rubiacearum*. These bacteria almost invariably inhabit the micropyle of the young seed, and, when the latter germinates, grow through certain stomata of the young leaves and into the intra-cellular spaces formed in the leaf-tissues around these stomata. Cavities are formed through the growth of the epidermal cells which later close entirely and make bacterial nodules which are deeply imbedded in the leaf tissues. A single leaf may have several dozen of these symbiotic bacterial nodules. Faber was able, by treating the seeds with hot water and a sublimate solution, to kill the inhabiting myco-bacteria, and, later, to infect part of the seedlings grown from these seeds with pure cultures of the bacterium. The artificially infected seedlings grown in soil free from combined nitrogen grew well and remained healthy for four months, whereas those not so infected turned yellowish-white and died in three or four weeks. The plants from unsterilized seeds produced leaves bearing many more bacterial nodules than did those from sterilized seeds which were later artificially inoculated.

In view of the fact that these rubiaceous plants with nodule-bearing leaves occur in many parts of the tropics, and that in India the value of their leaves has long been recognized, and considering the importance of nitrogen-fixing legumes as soil enrichers, the suggestion of Faber that we may have in these trees and shrubs plants of positive agricultural value deserves the serious consideration of tropical planters. If they can be grown as subsidiary crops beneath plantations of rubber, cacao, coffee, or other important tropical cultures, and their leaves allowed to accumulate upon the ground to serve as a mulch and as nitrogenous fertilizer, they may have great value. They differ from the leguminous cover-crops in that they are perennial in habit, and will not need to be replanted every year. It might be possible to prune them severely every year and utilize the clippings as fertilizer. The subject is one which opens up a new field in connection with tropical agriculture, and one which offers remarkable possibilities.

COLONIES OF NITROGEN-GATHERING BACTERIA ON A LEAF

The small dark spots visible on the under surface of this leaf are nodules containing colonies of a non-motile nitrogen-fixing bacterium similar to the one which inhabits the nodules on the roots of leguminous plants, and which makes the peas, beans and vetches valuable as green-manures or sources of plant food. These nodules have been found on the leaves of several tropical plants, and the question arises, Will it not be possible to use these species in the same manner as the legumes? (Fig. 11.)

THE INHERITANCE OF COAT COLOR IN GREAT DANES

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I. HISTORICAL OUTLINE

(*a*) *Description of the Breed.*—The Great Dane is known to all dog breeders as one of the most vigorous of the large breeds. Its origin is somewhat in doubt. Stonhenge (1873), in describing the breed, notes its frequent description under the name of Boar Hound and states that it . . . "does not appear to be a distinct breed, but rather a compound of the greyhound, the mastiff, and the terrier." On the other hand, Leighton (1907) believes that the antiquity of the breed is established by the fact that representatives of a type sufficiently similar to be considered its ancestors are found on early Egyptian monuments. Its more recent history appears to focus mostly on Germany, where it has been given the title of "Deutsche Dogge." For a long time it was, in all probability, crossed with other breeds of large German dogs such as the Hatzrüde, which is a medium-sized dog about intermediate in appearance between the heavy and thickset "dogge" type of the bulldog and the slimmer and less powerful "hund" type. Other somewhat similar varieties with which it may have been crossed are the Saufanger, Ulmer Dogge, and Rottweiler Metzgerhund.

But whether the Great Dane be considered as one of the oldest breeds or not really has little influence, from the viewpoint of the present investigation. It is sufficient that for a period of at least fifty years they have been recognized and selected with as great care as have the other breeds of thoroughbred dogs. Their color varieties are distinct and are well established as follows:

(*b*) *Color Varieties of the Breed.*—Stonhenge (*loc. cit.*) records the recognized colors of this breed as follows: "The color resembles that of the mastiff, being brindled or fawn, but sometimes of a bluish slate with blotches of brown." That several additional colors appeared and were recognized within a relatively short time is evident from the description of the orthodox colors given by Leighton, (*loc. cit.*) These are, according to his statement, brindle, fawn, blue, black, and harlequin. In the brindle dogs the ground color may be any shade from light yellow to dark red-yellow, on which the brindle appears in darker stripes. The harlequin should have, on a pure white ground, fairly large black patches which must be of irregular shape, broken up as if they were torn. The standard of the breed also states that, in harlequins, fawn and brindle shades are undesirable.

To reduce these color varieties to a simpler basis from a genetic point of view they may be listed as follows: Black (Fig. 12, No. 3); blue (dilute black) (Fig. 12, No. 6); harlequin (black and white), (Fig. 12, No. 2); brindle (Fig. 12, No. 4)—various shades including a dilute or "blue" brindle (Fig. 12, No. 7); fawn (Fig. 12, No. 5) —various shades including a dilute light, or "dove" fawn (Fig. 12, No. 8).

The fawn is tawny with dark-brown or black muzzle and feet. The dilute fawn has a dull, faded silvery appearance, quite well known to those who have seen such color varieties of rodents as dilute brown mice or dilute sooty rabbits. Fawn is, moreover, easily distinguishable from the yellow of pointers which is a clear, yellow-orange or lemon color, not nearly as rich or heavy in shade as the more brownish

pigmentation of the fawn. The blue is a true dilute type, apparently directly analogous to the maltese cat and the "dilute black" mouse or rabbit.

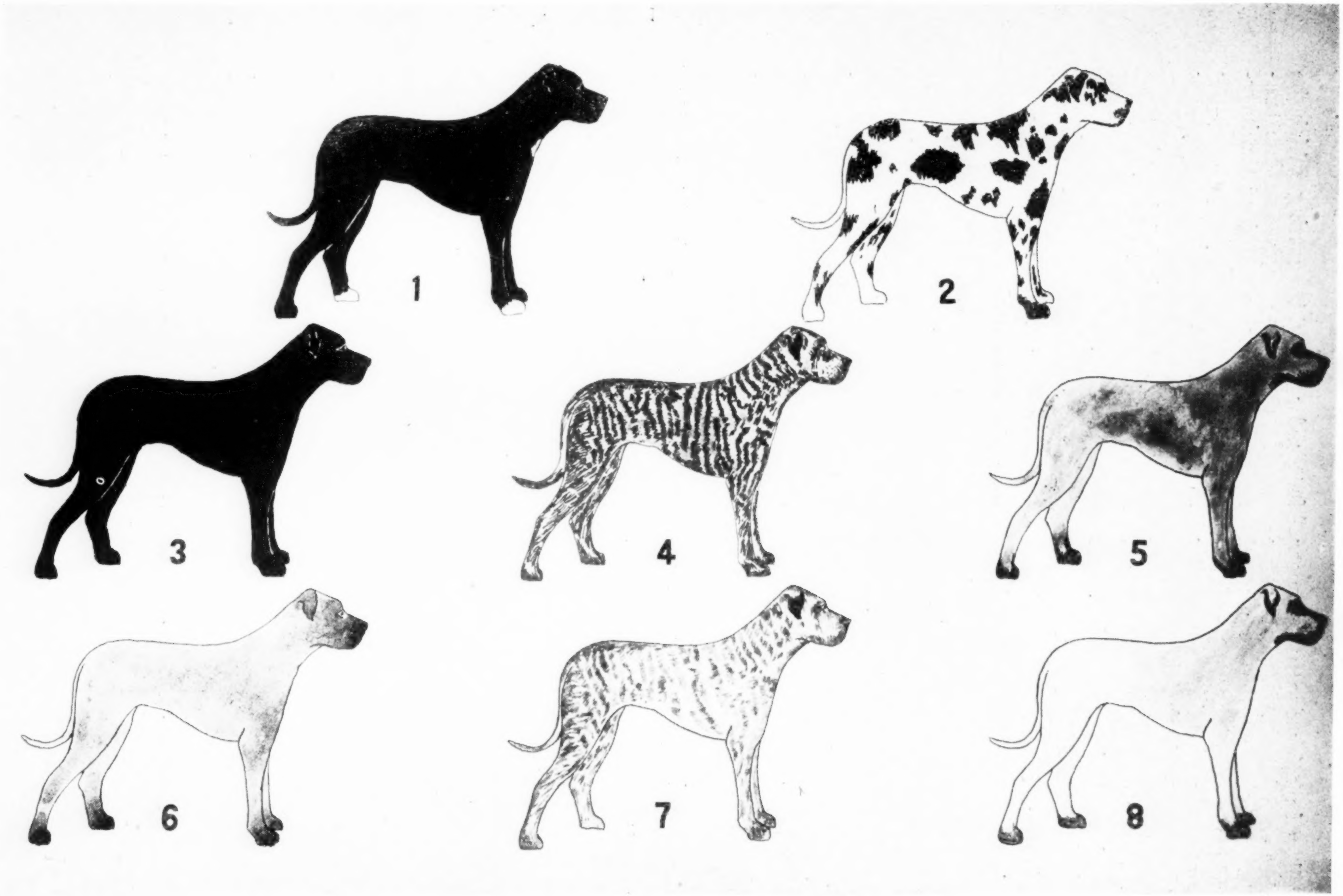
Brindles vary considerably in depth of color. They may have a rich, golden ground color or a duller and darker brown. The pattern which appears on this ground color is an irregular streaking with black. It is variously described as brindled, streaked, striped, or tigered. The relative amount of black and yellowish-brown pigment in the coat varies considerably, some brindles being almost entirely fawn with a trace of black, and others being predominantly, if not entirely, black, in appearance. Some evidence that brindles may rarely be entirely black in appearance or, at the other extreme, fawn, will be presented when the detailed color crosses are considered.

Dilute brindles have a dull, silvery type of coloration affecting both the ground pigment and the dark striping and giving an appearance easily distinguishable from the light but intensely pigmented brindles. The difference is qualitatively almost exactly that recognized in other mammals and described by one of the writers in the case of yellow mice (Little, 1911).

Spotted forms are of two sorts, harlequins already described, and dogs on which small white spots occur on the chests or feet. (Fig. 12, No. 1.) Harlequin is a pattern producing, on the one hand, a pure white animal with a dark nose, and on the other hand an animal with a very small amount of white. Individuals of the latter sort might possibly be confused with animals possessing spotting of the second (non-harlequin) type. Animals with the second type of spotting are not considered desirable specimens, and are in Great Danes, as in other breeds, vigorously selected against. The effects of this upon their occurrence and description will be considered later.

(*c*) *Review of Previous Literature.*—One of the writers (Little 1914) has used the American Kennel Club Stud Books for the purposes of studying color inheritance in pointers and has reportep the existence of certain alternative color types referable to Mendelizing factors. One of these, the factor for black pigment, the hypostatic form of which produces brown pigment, had been observed previously by Lang, 1910, in a single cross which he made. This mutation from large B to small b does not appear to have occurred in Great Danes in so far as the records studied are concerned. One dog was described as "liver" in color, but inasmuch as blue commonly approaches "liver" in appearance and, further, inasmuch as this dog occurred in a mating where blues would be expected, the dog in question has been classed as blue. The second factor to be recognized in pointers is the factor E for the extension of black and brown pigment in the coat. In the hypostatic form of this factor the colored portions of the coat are orange or lemon-yellow. Whether the yellow of pointers is identical with, or comparable to, the fawn type of Great Danes is doubtful. It represents a distinctly yellow type in which there is no marked darkening of the muzzle or the extremities such as one finds in fawn Great Danes. Until further careful experimentation is made, therefore, we shall have to recognize four distinct and possibly genetically different types of red-yellow coat pigmentation in dogs: First, the orange or lemon-yellow of pointers and English setters; second, the brownish-yellow of most "red" dachsunds, and possibly of Irish terriers; third, the dark, muzzled fawn of bulldogs, greyhounds, and Great Danes; and finally, the almost mahogany red of Irish setters. The genetic relationships of these four types would make a most interesting study.

In 1915, Barrows and Phillips found that the B and E factors were both present in cocker spaniels, and in addition discovered indications of a dilution factor producing dilute black or blue individuals and also, in the yellow series, cream or white. On page 393 they state that dilute reds are cream in color. Whether, however, dilute reds might not also be dull



COLOR VARIETIES IN THE GREAT DANE

In this breed of dogs several color varieties are distinct and well established. "To reduce these color varieties to a simpler basis from a genetic point of view they may be listed as follows: Black (No. 3 above), blue (dilute black, No. 6), harlequin (black and white, No. 2), brindle—various shades including a dilute or 'blue' brindle (No. 7), fawn—various shades including a dilute light, or 'dove' fawn (No. 8). (Fig. 12.)

faded yellow in color does not appear to have been considered. From analogy with all the forms previously worked on, in which a dilution factor of the type apparently existing in cocker spaniels has been established, one would expect that such would be the case. What we believe to be conclusive evidence of a dilution factor in Great Danes will be considered later.

The evidence on the inheritance of spotting obtained by Barrows and Phillips is extremely interesting, for it apparently demonstrates that there are at least two types of spotting. Thus spotted by spotted matings produced two hundred and twenty spotted and fourteen solid colored individuals. The spotted parents in these cases were apparently the ordinary parti-colored cockers in which considerable white is always present. When solid pigmented animals were crossed together, nineteen solid colored individuals were produced, and in addition two pups from a single litter showed very small white spots on the breasts. We shall see later that these conditions are paralleled closely in Great Danes.

Wright, 1918, in reviewing color inheritance in mammals, recognizes in dogs the existence of the B and E factors and of the dominant spotting which he calls R, or roan. Just how far this roan factor is similar to the fine mixtures of pigment found in the roans of horses and cattle is uncertain. It seems quite possible that in short-haired dogs such as Great Danes or coach-dogs, a type of color distribution which in the long-haired breeds such as English setters produces a mixture of indistinct spots and regions of apparent "roaning," might produce clear, well-defined spots. The possible danger of considering the dominant spotting found in cocker spaniels a true roan is seen in such varieties of dogs as the "tigered" or "dappled" dachsund. Here there appears to be a real intermixture of black, sparsely pigmented, and almost, if not entirely unpigmented hairs; a condition which more closely resembles the roans which have hitherto been described. Wright further recognizes a probable factor for piebald spotting which he considers at the present time unanalyzed. He also mentions the interesting experiments of Pearson, Nettleship, and Usher, resulting in the isolation of a factor for partial albinism in Pekinese. With this brief review we may now turn to a consideration of the observed facts.

II. OBSERVED EXPERIMENTAL RESULTS

The following matings have been recorded from data derived from the American Kennel Club Stud Books, Volumes 11 to 34 inclusive. As was the case in pointers, numbers before Volume 11 represented data collected at a time and under circumstances not well adapted to accuracy, and contained only a small number of available animals. The strong and weak points in data collected from stud books have already been touched upon in an earlier paper by one of us already referred to (Little, 1914), and need not be further considered at present.

Inasmuch as many types of matings have been involved, it will be convenient to analyze them in groups according to the particular factor or factors which we believe they possess.

III. THEORETICAL INTERPRETATION

A breed of dogs such as Great Danes may biologically be considered as a mixed population. In so far as any one pair of allelomorphs are concerned there will be individuals of three sorts: DD, DR, and RR. If there has been no particular degree of inbreeding or selection, they will probably be present in approximately the proportion of one DD, to two DR, to one RR. Considering for a moment only the D individuals we find that in proportion to the degree of inbreeding and selection, the relative number of DD individuals becomes greater, and we might therefore expect some populations to show among their D animals a ratio of one DD to one DR, or perhaps two DD to one DR.

For a population in which DD and DR animals are present in these different proportions, characteristic ratios of D to R individuals will be formed as the

		Black +white (harlequin)	Brindle +white	Dil-Brindle +white	Dil.-Black +white	Black	Dil.-Black	Brindle	Dilute brindle	Fawn	Dil.-fawn	White	Total
A	Harlequin (B & W) x Harlequin (B & W)	188	6		6	25	10	14	2			4	255
B	Brindle x Brindle	1	2	9	1	4	2	420	12	60	5		516
C	Fawn x Fawn							2		37	4		43
D	Dil-Blk x Dil-Blk			4			40						44
E	Brindle x Brindle & Wht		2					16	1	2			21
F	Fawn x Fawn & Wht									2			2
G	Blk. x Harlequin (B & W)	7				9	1	2					19
H	Blk. x Dil.-Blk					3	2						5
I	Fawn x Dil.-Fawn									14	2		16
J	Brindle x Dil.-Brindle							23	8	6			37
K	Brindle x Harlequin	4				3		2		2			11
L	Brindle x Black	1				9	1	7		4			22
M	Brindle x Dil.-Blk. & Wht	1						1	1				3
N	Brindle x Fawn		1				1	251	5	166	9		433
O	Brindle x Dil.-Blk	3	5			1	4	10	2	5	2		32
P	Fawn x Black					1		2		1			4
Q	Fawn x Harlequin	2								2			4
R	Fawn x Dil.-Blk					1	4	6	1	1			13
S	Blk. x Dil.-Blk. & Wht					1		2		2			5
T	Harlequin x Dil.-Blk	3					2						5
U	Harlequin x Brindle & Wht	5					1						6
V	Harlequin x Dil.-Brindle	1						1	3	2			7
W	Blk. x Dil.-Brindle					2		3	2	1			8
X	Fawn x Dil.-Brindle							6	5	2			13
Y	Brindle x Dil.-Fawn							17		6	1		24
Z	Brindle & Wht. x Dil.-Fawn							1					1
A^1	Brindle & Wht. x Fawn							1		1			2
B^1	Harlequin x Dil.-Blk	1					1	1					3
C^1	Dil.-Brind. x Dil.-Fawn								5				5
D^1	Harlequin x Dil.-Fawn							1					1
E^1	Dil.-Fawn x Dil.-Blk			1			1		2				4
F^1	Fawn x Dil.-Blk. & Wht		2	3				2					7
G^1	Harlequin x White	1							1				2
H^1	Brindle x White							5		2			7
I^1	Dil.-Fawn x Fawn & Wht							2		1			3
	Total	218	18	17	7	59	70	798	50	319	23	4	1583

result of random matings of D individuals *inter se* as follows:

D animals crossed *inter se*

Ratio of animals in population	Ratio of DD or DR animals to RR in progeny of random matings
(a) 1 DD : 2 DR.....	8 : 1
(b) 1 DD : 1 DR.....	15 : 1
(c) 2 DD : 1 DR.....	35 : 1

Similarly the incidence of DD and DR types in a relatively fixed proportion in any population will result in definite ratios from the back cross of D with R individuals. Any population which, in respect to a given pair of factors, gives, when D animals are crossed *inter se*, a ratio of type (*a*), (*b*), or (*c*), should approach the corresponding ratio in back crosses of D animals with R as follows:

D animals crossed with R

Ratio of animals in population	Ratio of DD or DR animals to RR in the progeny of random matings
(a) 1 DD : 2 DR.....	2 : 1
(b) 1 DD : 1 DR.....	3 : 1
(c) 2 DD : 1 DR.....	5 : 1

(*a*) *The factor D for intensity; d for dilution*

Matings involving these two color phases are tabulated in Tables II, III, and IV. In each case the mating designations refer to Table I.

It will be seen from Table II that the ratio of intense to dilute animals is approximately 15 : 1. We have, in the bottom three lines of the table, data which will serve to test how closely the observed figures conform with the expected numbers under an 8 : 1 and a 15 : 1 ratio. Figures for a 35 : 1 ratio are not, in this case, given because of the fact that it is obvious that the observed numbers are in closer agreement with a 15 : 1 ratio than they would be with a higher ratio.

TABLE II

Matings D and D

Mating	D Intense	d Dilute
A	233	18
B	487	29
C	39	4
E	20	1
F	2	..
G	18	1
K	11	..
L	21	1
N	418	15
P	4	..
O	4	..
U	5	1
A^1	2	..
Total (a)	1264	70 ± 5.49
Expected 15 : 1 (b)	1250	83 ± 5.94
Expected 8 : 1 (c)	1185	148 ± 7.83
Difference (a) and (b)	.....	13 ± 7.96
Difference (a) and (c)	.....	78 ± 9.56

The probable errors calculated in each case on the smaller phenotypic class show that between the observed numbers and the 15 : 1 ratio, there is a difference of 21 ± 7.5. The difference, which is 2.7 times the probable error, makes it not unlikely that the observed figures represent a chance deviation from this ratio. On the other hand, the difference between the observed figures and an 8 : 1 ratio is 86 ± 9.5. In this case the difference is 9.0 times its probable error, and the odds are practically certain that the observed figures depart significantly from an 8 : 1 ratio. This being the case, Table III, which records the cross of intense animals with dilute, should show a closer approximation to a ratio of three intense to one dilute than to a 2 : 1 ratio. This proves to be the case, although the numbers are so small that the difference between the observed figures and the 2 : 1 ratio cannot be considered as certainly eliminating the possibility that a 2 : 1 ratio is involved. However, inasmuch as the difference between the observed figures and the 3 : 1 ratio are less than the probable error, it seems extremely likely that the 3 : 1 ratio is the actual one involved.

TABLE III

Matings D and d

Mating	D	d
H	3	2
I	14	2
J	29	8
M	2	1
O	24	8
R	8	5
S	5	....
T	3	2
V	4	3
W	6	2
X	8	5
Y	23	1
Z	1	...
B^1	2	1
D^1	1	...
F^1	4	3
I^1	3	...
(a) Total	140	43 ± 3.8
(b) Expected on 3 : 1 ratio	137–46 ± 3.9	
(c) Expected on 2 : 1 ratio	122–61 ± 4.3	
Difference (a) and (b)	3 ± 5.4	
Difference (a) and (c)	18 ± 5.7	

Table IV shows the results of mating dilute animals *inter se*. While the numbers are small the results are consistent with the supposition that dilute forms are hypostatic to intense and all fifty-three animals obtained are dilute pigmented.

TABLE IV

Matings D and d

Mating	D	d
D		44
C^1		5
E^1		4
Total		53

(b) *The factors E for full extension, E^1 for partial extension, and e^1 for restriction of black pigment*

In the mixed population of Great Danes under consideration, the ratio of E, E^1, and e^1 types obtained when E forms are crossed *inter se* or with e^1 will be characteristically distinct and will give some idea as to the degree of inbreeding and selection involved. Thus:

Crossing E animals *inter se*.

Ratio of E types within a mixed population	Ratio of E to E^1 to e^1 animals obtained by random matings
(*a*) 1EE : 1EE^1 : 1Ee^1	32 E : 3E^1 : 1e^1
(*b*) 2EE : 1EE^1 : 1Ee^1	60 E : 3E^1 : 1e^1
(*c*) 2EE : 2EE^1 : 1Ee^1	75 E : 8E^1 : 1e^1

Crosses of E x E^1

Ratio of E types within a mixed population	Ratio of E to E^1 to e^1 animals obtained by random matings
(*a*) 1EE : 1EE^1 : 1Ee^1	4E : 1E^1 : 1e^1
(*b*) 2EE : 1EE^1 : 1Ee^1	6E : 1E^1 : 1e^1
(*c*) 2EE : 2EE^1 : 1Ee^1	7E : 2E^1 : 1e^1

Table V shows a combination of all matings involving the factor E. If the E x E matings be first considered, it will be noted that the ratio of 309E to 22E^1 to 2e^1 approximates very closely the numbers expected on a 75 to 8 to 1 distribution. Referring to the list of matings given above, it will be seen that the 75 : 8 : 1 ratio depends upon the supposition that EE and EE^1 individuals occur with equal frequency in a mixed population and which are each of them twice as numerous as Ee^1 animals. This is not at all unlikely, for blacks or harlequins (E) and brindles (E^1) are about equally popular in Great Dane breeding, and both of them appear far more frequently than do fawns (e^1).

TABLE V

Matings of EE^1 and e^1

Cross E×E

Mating	E	E^1	e^1
A	235	16	.....
D	44	.....	.....
G	17	3	.....
H	5	.....	.....
S	1	2	2
T	5	.....	.....
D^1	2	1	.....
Total	309	22	2
75 : 8 : 1 ratio	300	32	4

Cross E × e¹

Mating	E	E¹	e¹
P	1	2	1
Q	2	.....	2
R	5	7	1
D¹	.....	1	.....
E¹	2	2	.....
F¹	3	4	.....
Totals	13	16	4
7 : 2 : 1 ratio	22.4	6.4	3.2

Cross e¹ × e¹

Mating	E	E¹	e¹
C	.....	2	41
F	.....	.....	2
I	.....	.....	16
I¹	.....	2	1
Totals	.....	4	60

Cross E × E¹

Mating	E	E¹	e¹
K	7	2	2
L	11	7	4
M	1	2	.....
O	8	17	7
U	6	.....	.....
V	1	4	2
W	2	5	1
Totals	36	37	16

Cross E¹ × e¹

Mating	E	E¹	e¹
N	1	257	174
X	.....	11	2
Y	.....	17	7
Z	.....	1	1
A¹	.....	1	1
C¹	.....	5	.....
Totals	1	292	185 ± 7.18
2:1 ratio	.....	318	159 ± 6.94
Difference	.....	.....	26 ± 9.9

Cross E¹ × E¹

Mating	E	E¹	e¹
B	9	442	65
E	.....	19	2
J	.....	31	6
Totals	9	492	73 ± 5.38
8:1 ratio	.....	510	64 ± 5.08
Difference	.....	.....	9 ± 7.4

If a triple allelomorph series is involved between the factors E, E¹, and e¹, the only types of matings which should give all three phenotypes are E x E, E x e¹, and E x E¹. Such, however, is not actually the case. We find, for example, that there are nine E animals obtained in matings of E¹ x E¹ individuals in a total of 574 offspring. Similarly, there is one E individual in matings of E¹ x e¹ in a total of 477 offspring; and finally, there are four E¹ individuals in a total of sixty-four progeny produced by e¹ x e¹ matings. Some, or perhaps all of these exceptions might be explained by errors in recording parents or in the stud books. There appears, however, to be another possible explanation which should receive consideration.

If one examines a large number of specimens of brindle Great Danes, he finds that they vary greatly in the amount of black pigment which they possess. Some of them are so nearly fawn as to have only a small spot of dark hairs, while others are almost indistinguishable from blacks. This is a common condition in all brindle and similar patterns. It is found in yellow mice, tabby cats, and in agouti rabbits, mice, and guinea-pigs. That it is a recognized trouble maker in breeding brindle Great Danes is shown by the following quotation from Leighton (*loc. cit.*): "When brindle Great Danes have been continuously bred together it has been found that they get darker and

that the peculiar striping disappears, and in that case the introduction of a good fawn into the strain is advisable."

It seems therefore entirely probable that at least a part of the nine blacks (E) appearing in the $E^1 \times E^1$ matings and the one black appearing in the $E^1 \times e^1$ matings represent brindles of this extremely dark or blackened type, while the four brindles (E^1) which appear in matings of fawn x fawn may well be due to the fact that one of their parents was an extremely light brindle in which the black was so reduced that it appeared phenotypically like a fawn and was so recorded. The occurrence of exceptions of this type is therefore expected, provided that the brindle pattern of Great Danes behaves as all other similar pattern factors hitherto studied in mammals.

(c) *Factor H for harlequin spotting, h for absence of harlequin spotting or self coat.*

Inheritance of any form of spotting is complicated because of great variability in the degree of spotting, and of incompleteness of dominance in many cases, also because genetically different types of spotting all show themselves as simple contrasts between colored and white areas. Even with all these handicaps, however, the data obtained from the A. K. C. stud books indicate that there are at least two genetically different types of spotting in Great Danes. We may first consider the more striking of these, namely harlequin spottings. (Plate 1, Fig. 2.)

Animals of this type when crossed together have given, in addition to harlequin, a considerable number of self animals as shown in Table VI. From a fancier's point of view, harlequins by inbreeding continually tend to grow too light, that is, to have too little black pigment. The method followed to correct this is to cross harlequin with self intense blacks. (Fig. 12, number 3.) This leads to an increase in black areas on the resulting harlequins.

TABLE VI

Matings H×H				Matings h×h		
Mating	H	h		Mating	H	h
A	188	63		B	1	515
Totals	188	63	±4.63	C		43
Expected 3 : 1 ratio	188	63	±4.63	D		44
Expected 8 : 1 ratio	221	31	±3.57	H		5
Expected 15 : 1 ratio	235	16	±2.61	I		16
				J		37
				L	1	21
				N		433
				O	3	29
				P		4
				R		13
				W		8
				X		13
				Y		24
				C^1		5
				E^1		4
				Totals	5	1214

Matings H×h			
Mating	H	h	
G	7	12	
K	4	7	
Q	2	2	
V	1	6	
B^1	1	2	
D^1		1	
Totals (a)	15	30	±2.13
Expected (a) 1 : 1 ratio	22	22	±2.26
Expected (b) 2 : 1 ratio	30	15	±2.13
Expected (d) 3 : 1 ratio	34	11	±1.94
Difference (a)×(b)	7 ±	3.1	$\frac{\text{Diff.}}{\text{P. E. Diff.}} = 2.2$
Difference (a) and (c)	15 ±	3.0	$\frac{\text{Diff.}}{\text{P. E. of Diff.}} = 5.0$
Difference (a) and (d)	19 ±	2.89	$\frac{\text{Diff.}}{\text{P. E. of Diff.}} = 6.5$

Because of the generality of this practice one might expect that the great majority of harlequins would be heterozygous and that the result of crossing two harlequins would be to approximate a ratio of three harlequins to one self colored. This as can be seen from Table VI is exactly the result obtained, and we may therefore consider that it is extremely probable that harlequin represents a form of spotting depending upon a factor epistatic to self colored. Furthermore, when harlequins are crossed with self blacks, the small number of young obtained show a ratio which is not significantly different from a one to one ratio. This supports the view that the harlequins used for breeding are commonly heterozygous. The matings of animals lacking the harlequin spotting factor are last to be considered. These have given a total of 1,219 offspring. Of these, five, or less than four-tenths of one per cent, are harlequin, and the remainder are self as expected. It is extremely likely that these five exceptions are due to stud-book errors, for they occur so rarely that it is hard to believe that they are genetically significant.

The harlequin spotting factor appears to be not unlike the dominant spotting observed by Barrows and Phillips in cocker spaniels, although, of course, the actual distribution of the spots differs in the two forms, those of the Great Danes being far more irregular in outline.

(d) *The Factor S for Self Color, and s for "piebald" spotting*

The term "piebald spotting" is perhaps a misnomer, for apparently the only manifestation of this type of spotting which exists in Great Danes is the occasional occurrence of animals with a white chest spot or with white feet, or with both. Such an animal is shown in Fig. 12, No.1. Such forms are not desired and are rigorously selected against by fanciers. Inasmuch, however, as their appearance depends upon an hypostatic factor, the entire elimination from any strain has proved to be difficult, and they still crop out at rare intervals. That they appear less frequently than animals possessing the other hypostatic factors already considered is shown by Table VII. Here matings of self x self animals have given 1,214 offspring, of which

TABLE VIII

Matings S × S			Matings S × s			
Mating	S	s	Mating	S	s	
B	503	12	E	19	2	
C	43	.....	F	2	.....	
D	40	4	M	2	.....	
H	5	.....	S	5	.....	
I	16	.....	Z	1	.....	
J	37	.....	A^1	2	.....	
L	21	.....	F^1	2	5	
N	432	.....	I^1	3	.....	
O	24	5	Total	36	7	±1.63
P	4	.....	Expected 2 : 1	29	14	±2.7
R	13	.....	Expected 3 : 1	32	11	±1.93
W	8	.....	Expected 5 : 1	36	7	±1.63
X	13	.....				
Y	25	.....				
C^1	5	.....				
E^1	3	1				
Total (a)	1192	22	±3.14			
Expected : 1 (b)	1079	135	±7.38 Difference (a) and (c) 54 ±6.5			
Expected 15 : 1 (c)	1138	76	±5.69 Difference (a) and (d) 12 ±4.9			
Expected 35 : 1 (d)	1180	34	±3.87			

twenty-two are spotted. At the bottom of the table, a comparison between the observed figures and the numbers expected on 8 : 1, 15 : 1, and 35 : 1 ratios is made. It will be noted that the 35 : 1 ratio is most closely approximated and that this ratio probably means that there are two SS to one Ss individuals in a mixed population of self Great Danes.

Confirmatory evidence is obtained from the matings of self with spotted animals, also shown in Table VII. Here, a 5 : 1 ratio is expected if two out of each three self animals are SS in formula. So far as the numbers obtained are concerned, this expectation is exactly fulfilled, although the numbers are so small that without the additional evidence from the cross of self animals *inter se* it could not properly be considered as definitely proving the point in question.

(*e*) *List of factors known to date in dogs*

It may be useful at this point to make a list of color factors recognized in dogs, in order that their relations may be considered and that future experiments may be planned with them in view. They are as follows:

(1) *C*, the color factor, modification of which, c^1, produces partial albinism; (2) *B*, factor for black pigmentation, modification of which, *b*, produces brown or chocolate coat color, (3) *E* for extension of black and brown pigmentation, modification of which, *e*, produces orange or lemon-yellow coat color. It is possible that the black and tan pattern and the brindle and fawn coat patterns may fall into this series. The two latter are therefore, for the present, classed as follows: E^1 modification of *E* producing brindled coat pattern such as is found in Great Danes, bulldogs, Boston terriers, and greyhounds. e^1 modification hypostatic to E^1 producing fawn coat color ound in Great Danes, greyhounds, bulldogs, and Boston terriers. Further experimentation may serve to show that E^1 and e^1 are in reality not modifications of *E* but are genetically in a different allelomorphic series. One might, at present, if he so desired, class them as members of a separate series, until their relationship with the yellow of pointers and English setters is definitely established. We have, however, chosen to consider them as modifications of *E* until they are proven to be independent. (4) *D* factor for intensity of coat color, modification of which, *d*, produces dilute pigmentation of black, brown, or yellow coat color. This factor is distinct from the albino series and is comparable to the similarly designated factor described by Castle and Little (1909) in mice, or to the maltese dilution of cats described by Doncaster (1905), and confirmed by Whiting (1918), or to the dilution factor described by Castle and others (1909) in rabbits. (5) *H* factor for irregular white spotting (harlequin spotting)—many irregular colored spots on a white ground. The spotting is apparently independent of regional distribution on the body and is characteristic of harlequin Great Danes, but also possibly found in cocker spaniels and English setters. *h* modification of this factor producing, in the absence of any other factors for spotting, a coat without any white spotting. (6) *S* factor for self or solid coat color, a hypostatic modification of which, *s*, produces animals with a small amount of white, possibly confined to a chest spot or single foot spot. Quite probably from a mixed population such *ss* animals might be selected to form a race of true piebald animals with a considerable amount of white in the coat.

In addition to the above, several color phases occur which are undoubtedly referable to mendelizing factors. These may be listed as follows: (1) Black and tan coat pattern, apparently recessive to solid coat pattern. (2) Dominant yellow such as occurs in dachshunds. (3) R, a roaning pattern. This factor is seen in so-called "tigered" dachshunds and possibly in Blue Merle collies. It is in all probability dominant to solid coat and independent of the other factors listed above.

(*f*) *The Value of Dogs as Genetic Material*

Recent investigations of Malone (1918) have shown that there are in dogs two classes of sperm, bearing

eleven and ten chromosomes respectively. This being the case, it seems probable that dogs represent, even in spite of their slow breeding and large size, the best material available among the mammals for a relatively complete genetic analysis. They are found in more color varieties than occur in any other domesticated animals. They have more structural differences and a greater size difference between breeds as well as a greater difference in number of young per litter than are found in other mammals. There is apparently complete fertility between different breeds. Artificial insemination has been tried (Iwanoff, 1903) and has been found possible, a fact which might enable experimenters to overcome any mechanical difficulties in crossing very large with very small breeds. They possess more clearly defined instincts, characterizing various varieties than do other mammals. To sum up, therefore, it may be stated that if an investigator is willing to wait for his results, dogs provide a field unequalled among mammals in the respects above outlined.

IV. SUMMARY AND CONCLUSIONS

From a study of the breeding records of Great Danes in the American Kennel Club Stud Books, the following conclusions can be drawn:

1. There is a single mendelizing factorial difference between the intense pigmented (black, brindle, and fawn) varieties on the one hand, and the dilute varieties (dilute black, dilute brindle, and dilute fawn) on the other hand. The factor D for intensity is epistatic to its allelomorph d—the factor for dilution.

2. The three coat conditions represented by solid black, brindle, and fawn are dependent upon three mutually allelomorphic factors: E for full extension of black pigment, E^1 for its partial extension as seen in the brindling pattern, and e^1 for its restriction to the muzzle, nose, feet, and a small area near the eyes—a condition typical of the fawns. Black (E) animals may carry either brindle (E^1) or fawn (e^1) but not both; brindles (E^1) may carry fawn (e^1) but not black (E), and fawns (e^1) can carry neither brindle (E^1) nor black (E).

3. Harlequin spotting (H) is epistatic to solid coat color (h) and apparently differs from it by a single mendelizing factor.

4. Minute white spots on the chest or on the feet occur rarely among the progeny of solid colored animals. Their appearance is probably due to a factor (s) for piebald spotting which is hypostatic to its allelomorph (S) for self coat color.

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OLNEYA BEANS

A Native Food Product of the Arizona Desert, Worthy of Domestication

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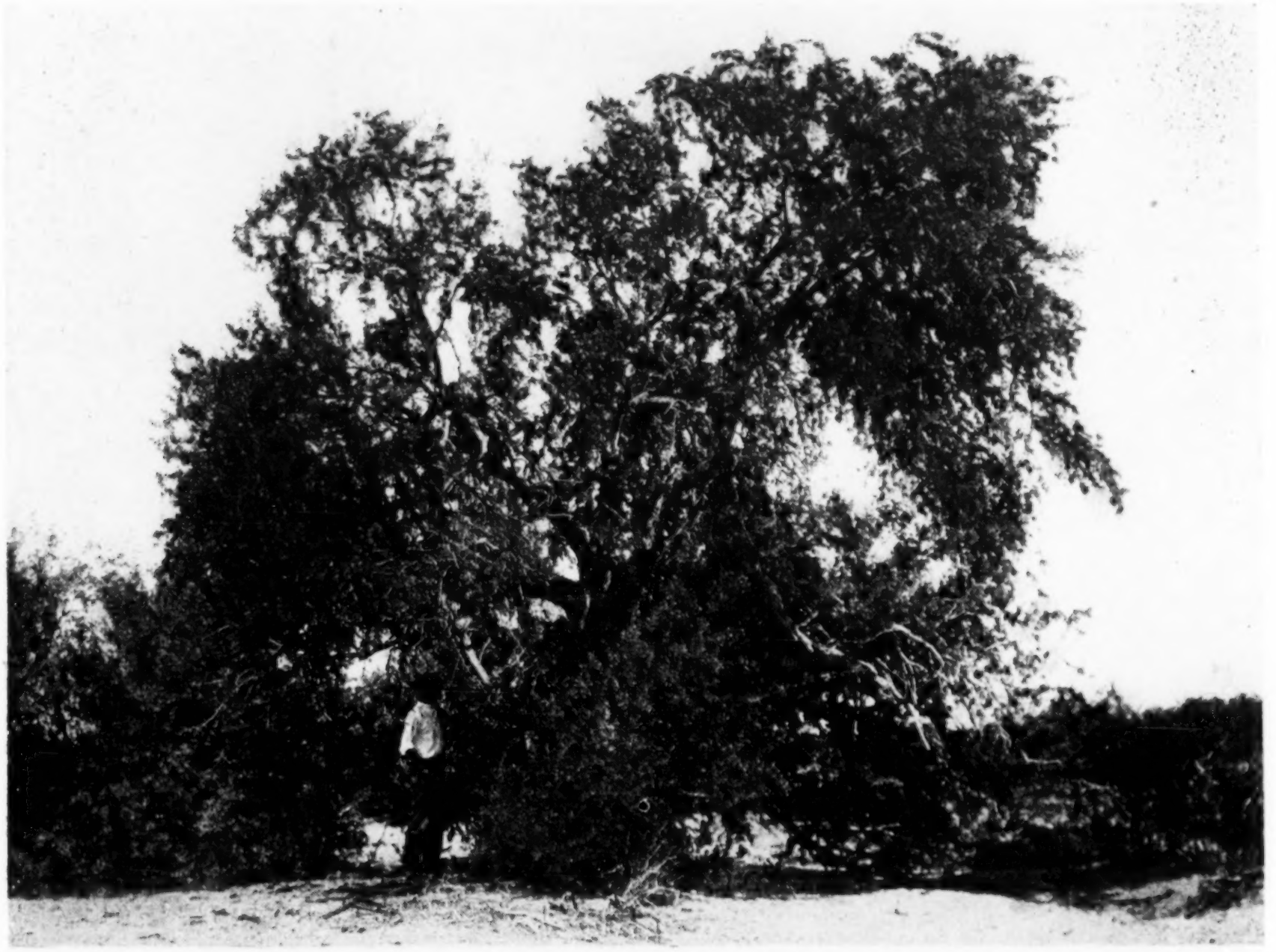
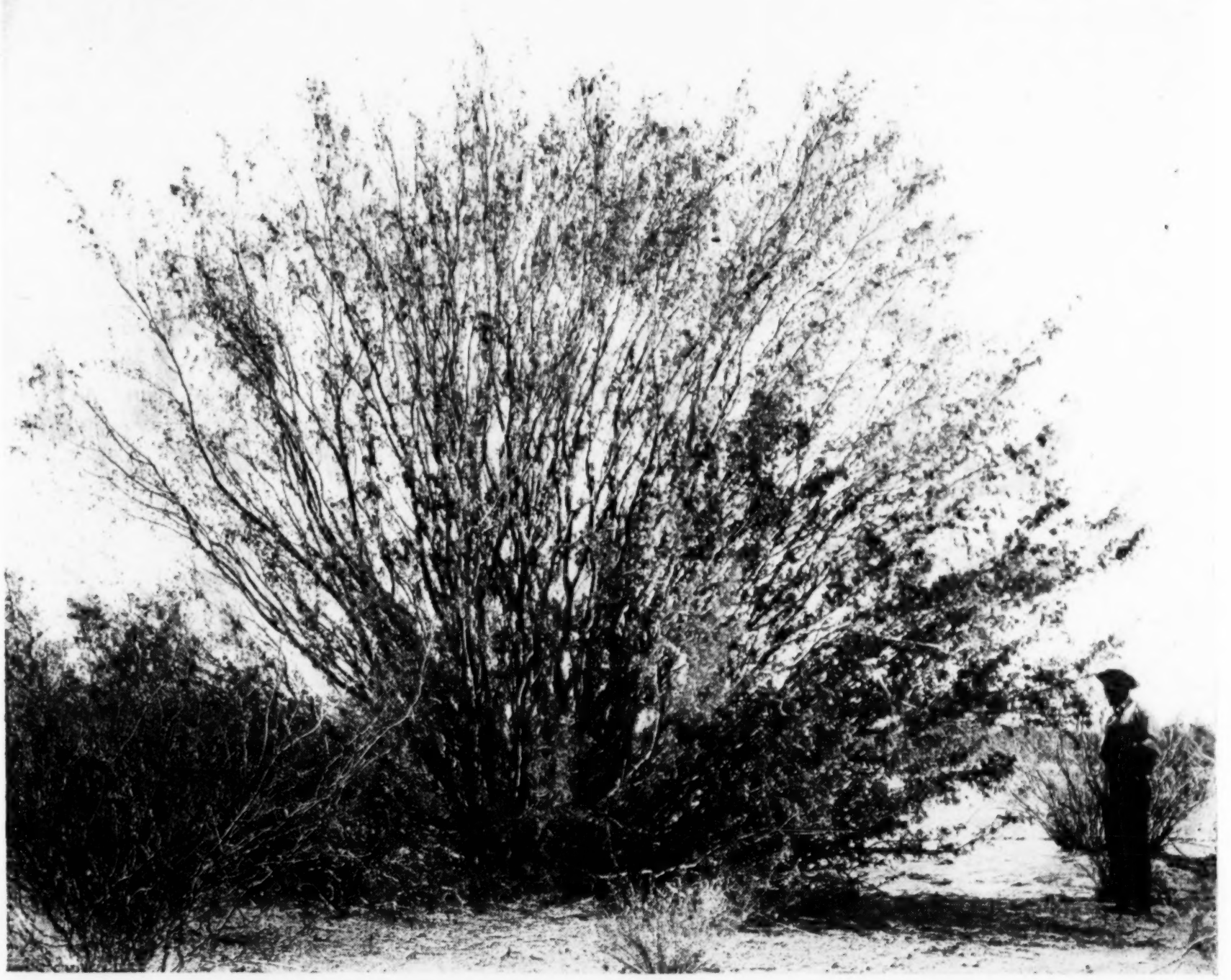
So many different trees are called ironwood in other parts of the United States that further use of this name for *Olneya tesota* should be avoided. As the tree is confined to the southwestern deserts, names like "desert ironwood," "southwestern ironwood," or "Sonora ironwood," the last proposed in Britton's "Trees of North America," might serve, but such compounds are too awkward and tedious in repetition to be used consistently. The Mexican name, *palo fierro* or *arbol de hierro*, meaning *iron tree*, may come into use, since *palo verde*, meaning *green tree*, has been adopted generally in the southwest for another leguminous tree (Cercidium), which is a regular companion of Olneya in the desert. But *palo fierro* and *arbol de hierro* are not more distinctive names in Spanish than ironwood in English, and are applied to trees of many kinds in Mexico and other parts of tropical America. Use of the generic name Olneya, or the name *tesota*, recorded by the Mexican boundary explorers and recognized in Gray's botanical designation of the species, would avoid the difficulties.

The only economic feature of Olneya noted in botanical works of reference is that the wood is very heavy, hard, and difficult to work, though sometimes used for special purposes and generally valued as fuel. Possibilities as an ornamental are suggested by Britton's reference to Olneya as "a most beautiful tree." The grayish foliage and gnarled trunks give a slight similarity to the olive, set off in May by an abundance of pinkish-purple blossoms, in form like those of the locust tree, to which Olneya is related. It is the largest as well as the most attractive tree that grows as a true native of the driest southwestern deserts, away from the stream beds and with full exposure to heat and drought.

A forage value is recognized in "New Trails in Mexico," by Lumholtz, who tells how the mules, donkeys and horses left good grass to feed on the leaves of palo fierro. "They stretched their necks like giraffes in eager competition and, paying no heed to its numerous thorns, they pulled away mouthfuls of leaves." This has to be corrected to the extent that Olneya has no true thorns like those of the mesquite, but as in the screw-bean there are slender spine-like stipules 4 or 5 mm. long on the upright shoots, though the smaller twigs are unarmed. Referring to a district in Sonora, between Santa Ana and Trincheras, Lumholtz also says: "For three or four hours we were crossing a large, low mesa with a predominant vegetation of palo fierro trees, the leaves of which furnish here the sole subsistence for herds of cattle. They grow fat on this, drinking water only every third day." The flowers also are said to be eaten as they fall to the ground, and to fatten the stock.

Thus we have Olneya as a handsome flowering tree, with a dark, heavy, hard wood like ebony, and with foliage and flowers that are eaten with avidity by animals and are nutritious, like alfalfa. To this reckoning must be added the fact that the Olneya trees bear thick crops of pods not unlike those of garden beans, and that each pod may have several seeds, unlike the small bony seeds of the mesquite, but of the size, appearance and texture of small peanuts and having the same agreeable flavor when roasted, so that they can be used as food. Young pods probably could be cooked and eaten like green beans, since the texture is fleshy and the taste not bitter, even in the raw state,





THE OLNEYA TREE

Above, the largest Olneya tree in the vicinity of Sacaton, Arizona, about 30 feet high and 2 feet in diameter. Below, an Olneya tree cut off near the ground, with a new crown of upright sprouts, bearing a large crop of beans. (Fig. 13.)

though somewhat astringent. The pods are not limited to one or two seeds, as the works of Gray and other botanists would indicate, nor is the tree of very slow growth as commonly supposed, from its behavior under extreme desert conditions. In short, Olneya is a tree that may be found worthy of cultivation, in spite of the fact that it is not planted or even allowed to survive around any of the southwestern settlements.

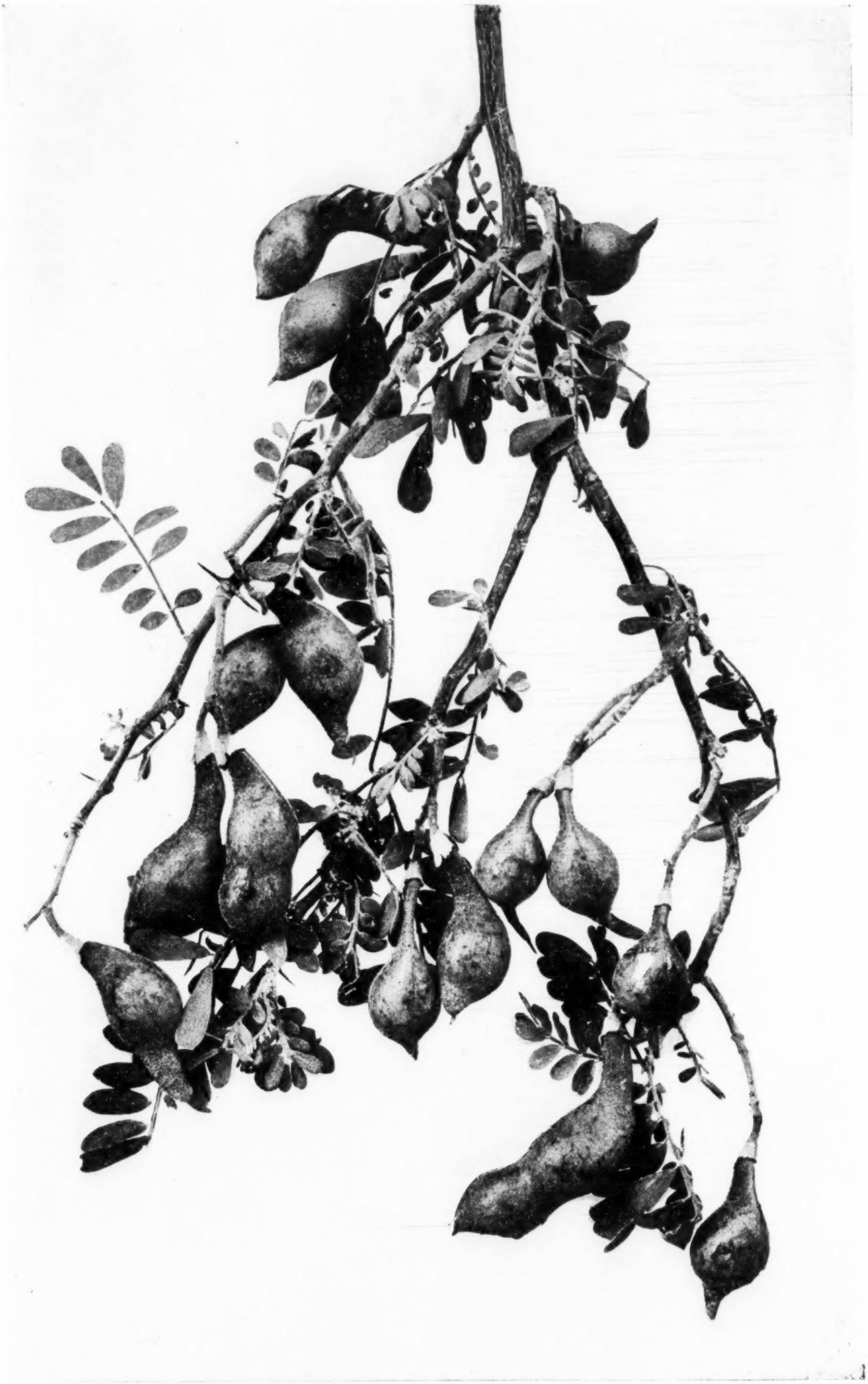
It seems remarkable that the production of edible beans by Olneya was not the first fact to be recorded, or at least one of the first to attract attention, but this feature of the tree has remained practically unknown, even among those who have lived long in the southwest. One reason may be that the beans ripen about the first of August when even botanists and explorers avoid the hot deserts. Emory passed through the Gila Valley in November, 1846. Bigelow's specimens of Olneya were collected in northern Arizona in February, 1854, and are said by Torrey to be "in fruit only," no doubt the empty pods of the previous season. Bigelow states that the Mexicans who accompanied the Whipple Expedition, and who doubtless joined it in New Mexico, were not acquainted with the tree nor with the name *tesota*. It seems not impossible that the tree at first was confused with the mesquite or the "cat's claw" acacia, the latter also said to have been called *tesota*. The word *tezoatl* appears in Simeon's Aztec dictionary as the name of a shrub of the hot lands, the leaves of which are used to make a dye, while *texotia* or *texotli* is an Aztec word for a blue color. In the Pima language the tree is called *hait kam*, according to Russell.

The first Olneya beans that came to my attention in October, 1916, were in the hands of a venerable prospector living near the abandoned town of Picacho on the California side of the Colorado River, about 30 miles north of Yuma. A stock of the beans had been collected for eating and to make a beverage that was compared to chocolate. The old prospector's "native peanuts" were remembered in July, 1918, on seeing abundant crops of pods on many of the Olneya trees in the deserts around Sacaton, in south-central Arizona, and as the beans ripened many differences were noted, some of practical interest from the standpoint of cultivation.

No two trees seem to produce exactly the same kind of beans. Usually the difference between beans of neighboring trees were not merely appreciable, but obvious, and comparable to those that distinguish cultivated varieties in other genera of the pea family. Corresponding differences were noted in the pods and in the characters and behavior of seedlings of the same parent tree. Many writers assume that wild species normally are uniform, and that diversities among cultivated plants are induced by conditions of domestication or by hybridization. But Olneya is a monotypic genus, and individual diversity or heterism, instead of uniformity, appears as the normal condition among the wild trees growing in their native deserts.

Though only one bean in a pod is the rule on some trees, it usually is possible to find some pods with at least two or three beans. Many trees have pods with several seeds, and some are distinctly large-podded, to the extent of nearly 13 cm. in length and 10 to 12 mm. in width, in the dry state. The largest pods had nine fully developed beans and two abortive, indicating that pods with eleven beans or more are sometimes produced. The number of seeds is a practical consideration, since gathering beans from trees with only single-seeded or two-seeded pods is much more difficult than from those that have pods with several beans. The color of the young pods is a light yellowish or brownish-green, sometimes mottled with red, as the pods of the Arizona mesquite often are. The color darkens to light coffee brown as the pods dry and shrivel.

Other differences between individual trees are in the proportioning of the pods to the beans. If the pods are ample so that there is no crowding, the



A NEGLECTED AMERICAN FOOD PLANT

"In view of the several possibilities of use it may seem strange that Olneya has not been cultivated before or that it was not domesticated by the native agricultural tribes of the southwestern States or of Mexico, but tree-crops were not a general feature of the native American agriculture." This photograph shows a branch of Olneya with nearly mature pods, from a tree that produces only one or two beans in a pod, as stated in botanical descriptions of the species. (Fig. 14, natural size.)

beans are regular in shape, but some trees have relatively shorter pods, so that the beans are crowded and flattened at one or both ends, and hence irregular in size and form, which would increase the difficulty of mechanical cleaning and sorting (Fig. 16). Some trees have relatively indehiscent pods that fall to the ground without shattering, while on other trees most of the pods open before falling, so that the individual beans have to be picked up, which takes much more time and labor.

Color also appeared as a practical consideration in collecting the beans, for those that were light-colored, grayish or brownish, were more difficult to find than the dark purple beans of other trees. The most difficult beans to pick up from the ground were light brown and finely speckled, these being hard to detect among the litter of coarse sand or gravel, fragments of dead wood, dry leaves, and pods under the trees. The colors range from a uniform light tan through various degrees of shading, mottling, and speckling with dull or pinkish purple to nearly uniform deep purple, nearly black in the mass.

From the standpoint of general desirability and ease of handling it seemed that the best trees to select would be those that bore abundant crops of long, many-seeded pods, not opening too readily, with large, plump, regularly formed beans, of the dark purple color. One such tree was found that seemed definitely superior to any other in combining the several requirements. Photographs of this tree were made, as well as of the pods and beans, and a part of the seed was planted at Sacaton, as Olneya No. 1 (see Figs. 13 and 17, No. 4). This tree had pods of the largest dimensions, as given above, with beans attaining 11 mm. in length, 9 mm. in breadth, and nearly 8 mm. in thickness. The surface of the beans is smooth and even, but under a lens shows very minute, close-set punctations. The hilum is white and rather prominent, and there is a small oval pit above the hilum, usually white and flat at the bottom, but sometimes reduced to a short, narrow groove. On the other side of the seed, diagonally across from the hilum, is a rather indistinct, broadly rounded prominence.

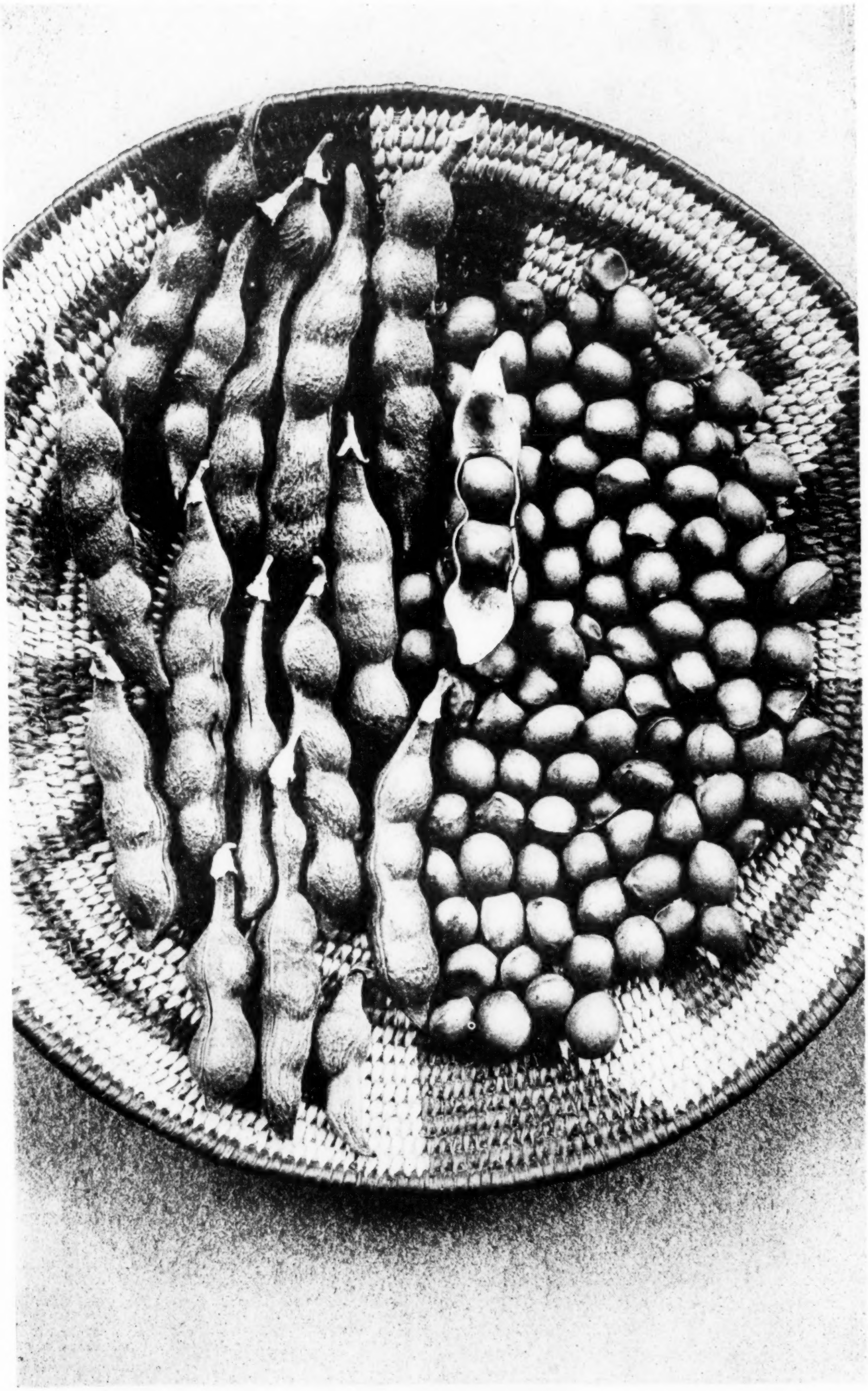
Still larger beans, with measurements of 12 mm. by 9.2 mm. by 7.2 mm., were obtained from another tree. These were of a nearly uniform light tan color, very finely speckled with purplish, and with much larger and less numerous punctations. Beans from several trees were weighed carefully by Mr. Harold F. Loomis. Averages of ten weighings of 50 seeds from samples representing seven individual trees were 13.617, 14.808, 14.231, 7.895, 12.682, 14.431, and 10.252 grams. The corresponding average weights of single beans of the seven trees are 0.272, 0.296, 0.285, 0.158, 0.254, 0.289, and 0.205 grams. The largest bean weighed 0.395 gram, with 0.357 gram as the average of 25 of the largest beans from the same tree, and 0.302 gram as the average of the sample from this tree, or nearly twice the average for the tree with the smallest beans. The largest beans are shown in Fig. 15, the smallest in Fig. 17, No. 2 and those of the tree considered most desirable in Fig. 17, No. 4. The tree with the largest beans bore only a small and late crop and had short pods, mostly with only one or two seeds, though a few had three or four (see Fig. 15).

The tree selected to furnish seed for planting was near the Pima village of Santan, north of the Gila River, opposite Sacaton. Two quarts of beans were collected from this tree. These were only a small part of the crop, but the others could not be gathered because of heavy rains that made the river impassable.

In the deserts around Sacaton only a few of the trees are large, most of them being sprouts from old stumps. Even the second growth is cut down as soon as a thickness of a few inches has been attained, although the yellow sapwood of the new growth is rather soft and is consumed rapidly by boring beetles. Cutting the older trees reduces the seed supply, and the second growth is browsed by cattle until the foliage is beyond reach. Browsing is worse, of

OLNEYA BEANS

Numerous variations occur in the size and character of the beans produced by Olneya trees. The ones here shown were the largest found in the vicinity of Sacaton, Arizona. (Fig. 15, natural size.)



BEANS AND DRY PODS

The dry pods of Olneya are firm in texture and not promptly dehiscent. The beans, which are somewhat crowded in the pods, are flattened at each end. (Fig. 16, natural size.)

course, in the vicinity of settlements, and the complete absence of tesota trees from the lower ground along the Gila River for several miles above and below Sacaton may be due to this cause rather than to susceptibility to frost. Like the giant cactus, Olneya does not come down to the river-bottom lands, but appears to be confined to the higher slopes, farther back toward the foothills. In both cases human activities and domestic animals may be important factors in reducing the chances of survival and of natural reproduction in the immediate neighborhood of the Indians.

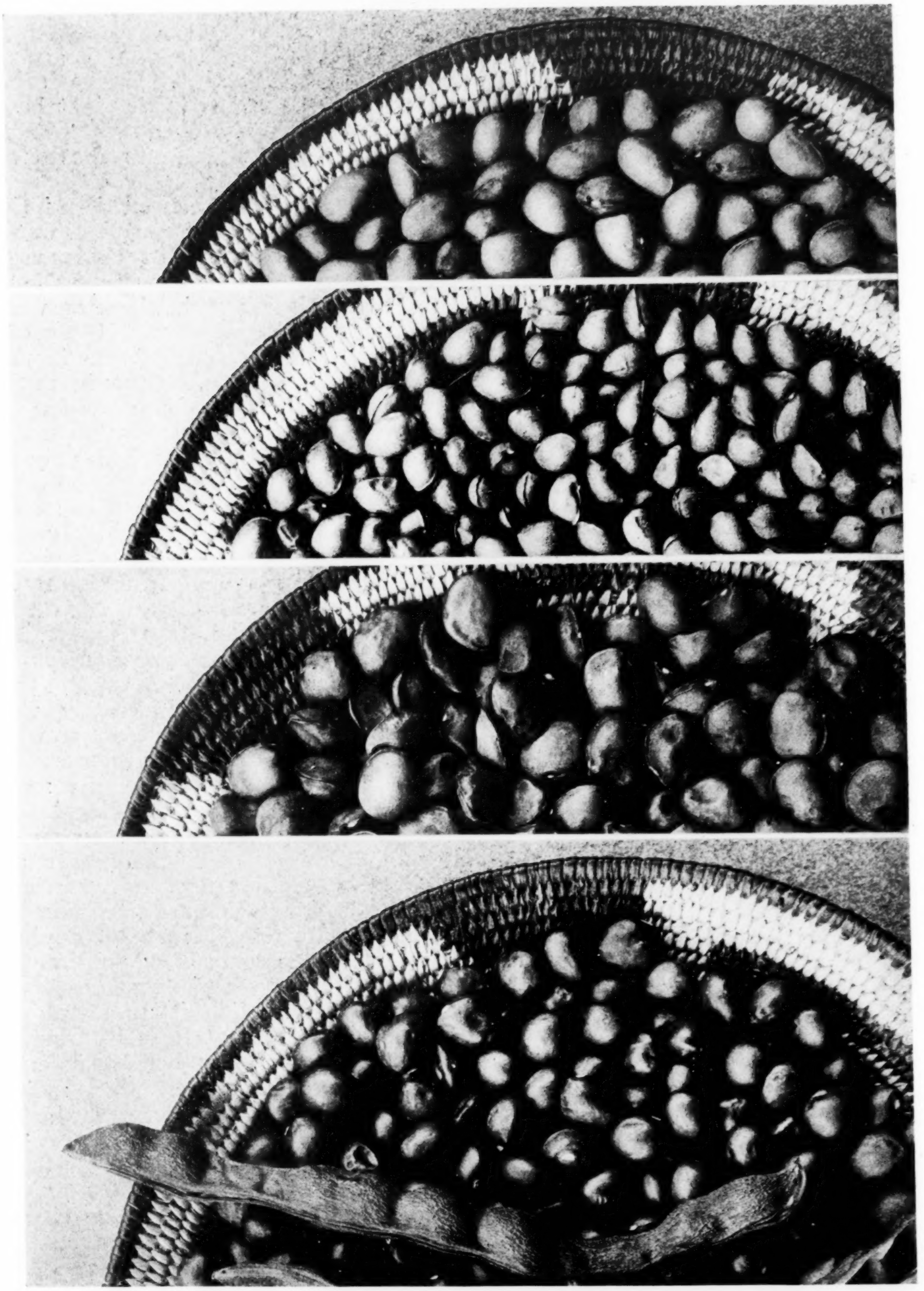
Cattle may be responsible also for the extreme scarcity of young trees, which are seldom to be found in the Sacaton district, even well back in the desert. Although an abundance of small seedlings sprang up under many of the bearing trees after the August rains, they disappeared completely in a few weeks. No doubt the rabbits and other rodents, as well as the birds and insects, must always have taken a heavy toll of the young plants, but there must have been provision for this in the natural economy of the species. It may be that rabbits have become more destructive to the Olneya seedlings, since Pimas began to keep cattle about the middle of the last century.

Cattle are said not to range more than 3 or 4 miles from water, but the woodcutters go farther into the desert, so that a general reduction of the seed crop from this cause also has to be recognized, and this again may help to explain why the Indians have ceased to gather the beans in recent decades. The range of wood-cutting depends, of course, upon the price, which often is very high. The use of Olneya wood for fuel has been very extensive, second only to that of mesquite, not only in Arizona but in the adjacent regions of Mexico. Railroads, mines, machine-shops and irrigation pumping plants have often used wood, in default of coal. Lumholtz explains that the easiest way to fell a tree is to make a fire at the base: "It ignites easily and burns the whole night through without any further attention."

It is apparent that only the extreme hardiness and tenacity of life of the old stumps and roots are responsible for the present representation of the species in many localities, and that when the vitality of these relics is finally exhausted a rapid extermination of the species must be expected, not merely from lands that can be brought under cultivation, but in the deserts where no other tree seems as well adapted to grow, except the useless *palo verde*. The possibility of retarding the destruction of the natural supplies or of propagating the species artificially might be worthy of consideration from the standpoint of fuel supply, even if there were no food or fodder possibilities to attract attention.

The possibility of making practical use of the natural supplies of the beans by gathering them from the wild trees in the desert is a question that might be raised in localities where the trees are still abundant, as they are said to be in some parts of the Papago country, in southern Arizona. There can be no doubt that the Indians used them formerly, though in recent years they seem to have been entirely neglected. One reason may be that needy Indians could get supplies of flour and other rations issued by the Government, and the increasing scarcity and remoteness of bearing trees undoubtedly would discourage any habit of relying on them for food. The fact that the bean harvest came at the period of the summer floods when the Indians were busy with their farms might also tend seriously to interfere with the gathering of the beans. The case is different with the mesquite, which has very hard, inedible seeds, and is spread by cattle and horses that eat the sweetish pods, which the Indians also grind and bake into loaves like bread.

If a systematic effort or test of the possibility of gathering tesota beans from the wild trees were to be made, no doubt the first step would be to cut off the low limbs and clear away



VARIATION IN OLNEYA BEANS

Samples of Olneya beans from four different trees are here shown, to illustrate variation in size, shape, color and other features. Nos. 1, 2, 3, 4, top to bottom. (Fig. 17, natural size.)

the bushes and the brushwood that accumulate under most of the trees, so that wagon-sheets could be spread to catch the beans, which could be knocked off readily with poles, most of the trees being low.

Picking up beans from the coarse gravel and vegetable debris under the trees is rather slow work, about an hour being required to collect a pound. But if values were to be reckoned on the basis of shelled peanuts, which are often sold at 50 cents and upward per pound, even this most laborious method of gathering the beans might appear justified if bearing trees were readily accessible.

Another question that naturally suggests itself is whether profitable yields could be obtained by planting the trees in orchard form. At present there are no data bearing on this subject beyond the fact that some of the wild trees are very prolific, so that a yield of half a bushel of beans per tree seems not impossible. At this rate of production orchard planting of Olneya might prove remunerative, and it might be found that other crops could be raised on the same land, as in the subculture system used in the desert oases of North Africa and other parts of the world. Even if the beans were not harvested for human use, turkeys or pigs might keep them from being wasted. Stores of beans collected by the desert rodents are said to have been drawn upon largely in former times by the Indians.

How rapidly the trees would grow, and how soon they would begin to bear if planted under favorable conditions, have still to be learned, since there appear to be no records of such experiments. Small stunted trees with trunks only 3 or 4 inches in diameter sometimes produce beans. Sprouts from old stumps may begin bearing when only 1 or 2 inches thick.

A first planting of Olneya at Sacaton in August, 1918, was lost, all of the seedlings being eaten off close to the ground, probably by rabbits. A second planting early in September, with wire protection, grew rapidly, and many of the seedlings were over a foot high by the end of October. Unlike some members of the pea family that have seedlings with simple leaves, Olneya has only compound leaves above the cotyledons.

That rapid growth may continue if the trees receive a regular supply of water is indicated by the fact that many vigorous new shoots, 4 or 5 feet long and over half an inch in diameter, were produced in the season of 1918 on old trees watered from a new well in the desert near Sacaton. Trees in rapid growth and in full leaf produce few or no beans, while trees that bore the heaviest crops of beans had only a sparse development of leaves.

It appears that Olneya, like many other desert trees, is extremely deep-rooted, so that transplanting may prove difficult or impossible. In an effort to transplant an Olneya tree from the desert near Yuma, reported by Mr. R. E. Blair, no lateral roots were found near the surface, and for 7 or 8 feet the large taproot remained entirely unbranched. Such a habit of root growth would indicate little or no interference with surface crops, so that Olneya may prove well adapted for planting in or near cultivated lands and may serve very well for hedges or wind-breaks, as well as for holding terraces or barriers against erosion, which are often needed in agricultural development of sloping mesa or foot-hill lands of the southwest. Even on desert lands that are too broken for irrigation it might prove worth while to plant belts of Olneya across the washes, to hold back and spread the flood-waters. More moisture would be absorbed by the soil, and more vegetation could grow in addition to the forage than the Olneya itself would afford.

In view of the several possibilities of use it may seem strange that Olneya has not been cultivated before or that it was not domesticated by the native agricultural tribes of the southwestern states or of Mexico, but tree-crops were not a general feature of the native American agriculture. The most conspicuous exception was cacao, which

seems to have been grown rather extensively as a subculture under larger forest trees in tropical districts of Central America. Most of the tree products are perishable, and the time required for trees to come into bearing is another reason for their not being popular among primitive peoples, who seldom cultivate the same land continuously for more than a few seasons.

The Sweetest Leaf Known

Several years ago a report ran through the press, originating in Asuncion, Paraguay, to the effect that there was a plant which grew wild on the prairies there, by the name of "Kaá Hee," *Eupatorium rebaudianum* (correctly determined later as *Stevia rebaudiana*) which had a substance in it 180 times as sweet as sugar. This report startled the sugar cane and sugar beet growers all over the world, and their fears were not allayed until it was discovered that the sweet substance was a glycerine and not a true sugar. Only the tiniest leaf fragment at that time reached Washington, and all efforts to secure the seeds of this interesting composite have until recently failed, but several ounces of the dried leaves and a small amount of seed have been received by the Department of Agriculture, through the American consul, and they have aroused a keen interest in all who have tasted them. A fragment a quarter of an inch square is as intensely sweet as saccharine. There is today so much discussion among dietitians as to the effects upon the health of the excessive use of cane sugar that the whole question of gratifying our most unusual taste for sweets is one deserving serious consideration. This is, as Professor Blaringham, of the Pasteur Institute, remarks, the age of sugar, "La siecle de sucre," but whether the fashion for sweets will be outgrown is a question for the dietitians to struggle with. Professor Osterhout, of Harvard, has shown that sugar increases the electrical permeability of the protoplasmic membrane of the cell, but just what inference is to be drawn from the discovery is a question. Having possibly a bearing upon this same problem, the following fact recently called to attention is worthy of publication:

"In southern Nigeria, according to Mr. A. H. Kirby, Assistant Director of Agriculture at Ibadan, there is a fruit tree or shrub known as the "Agbayun" (*Synsepalum dulciferum*), the slightly sweetish fruits of which, when eaten, have the peculiar property of making the sourest-tasting substances such as limes, lemons, unripe fruits, or vinegar which are eaten within twelve hours or so afterward, seem intensely sweet.

Here would appear to be two substances, both worthy of investigation from the modern standpoint of foods. Seeds of both of these plants have been imported by the Office of Foreign Seed and Plant Introduction,—U. S. Department of Agriculture.

RACIAL ORIGINS AND HONORS OF WAR

The Anglo-Saxon Element and the Heroes It Produced

FREDERICK ADAMS WOODS
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THE possession of an Anglo-Saxon surname is not a proof of Anglo-Saxon descent, but it is at least a strong indication of probability. There have been a good many instances of Jews changing their names, presumably with the idea of concealing their real racial origin; and since the outbreak of the war many citizens of German parentage have shown a similar tendency. The Irish, who form a very large proportion of the entire population in Boston and its vicinity, are, on the contrary, proud of their race, and are not at all prone to change their ancestral cognomens. Whatever the error may be in assuming the surname a criterion of race, it is not a large one.

On the return to New England of the 26th Division (Y. D. or Yankee Division) of the overseas army, a great parade was held in Boston, April 25. The *Boston Globe* of that date published the pictures and names of all the chief heroes of that division, divisional, brigade, and regimental leaders, and all receivers of distinguished service crosses —commissioned officers, noncommissioned officers, and privates—369 in all.

Of the noncommissioned officers and privates, 170 out of 236 bore Anglo-Saxon names. This is over 72%. Commissioned officers of Anglo-Saxon names who had received distinguished service crosses numbered 46 out of 63, or over 73%. Of the 51 divisional, brigade and regimental leaders, 40, or over 78%, bore Anglo-Saxon surnames.[1]

The proportion of Anglo-Saxon names in the entire division is probably not as great as 72%[2] and if this be true, we have in these figures some proof for the assertion, so often made, that the Anglo-Saxons, and particularly the Yankees and the Canadians, who resemble them in race, and the Scotch, who carry a large proportion of Anglo-Saxon names, are particularly heroic and make fine soldiers.[3]

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[1] Anglo-Saxon: Arnold, Ashworth, Baker, Bamford, Bearrs, Bishop, Bulkeley, Bunnell, Chase, Cheatham, Cole, Dowell, Edwards, Foote, Gatchell, Glassford, Goodwin, Greenlaw, Greenway, Hale, Hays, Herbert, Hobbs, Howard, Hume, Isbell, Jones, Keville, Lock, Major, Parker, Petts, Sanborn, Shelton, Sherborne, Smith, Sweetser, Waterman, Whalmsley, Wheelock. Others: Aultman, Dolan, Durfee, Lassiter, Logan, Mack, McCaskey, Meyers, Murphy, Traub, Twachtman.

[2] This total proportion of Anglo-Saxon names in the entire 26th Division was probably not far from 50%. This is indicated by the fact that an examination of a long list of names, about a thousand in all, including those who received citations, commendations, congratulations, etc., but who did not receive distinguished service crosses, gives about 55% Anglo-Saxon names. List published in *Boston Evening Transcript*, April 25, 1919.

[3] As a criterion in deciding doubtful cases, use was made of Bardsley, C. W., "A Dictionary of English and Welsh Surnames with Special American Instances." London, 1901.

A Dangerous Horse Situation

We can well liken the horse business to an ocean. At times come tides, at other times comes the ebb flow. Just now the tide is setting very strongly in one direction—that of getting out of the horse business. Due to the inability of horse prices to follow the large increases in prices of wheat, corn, pork, beef and mutton, many farmers have quit the horse business. Their mares have been for sale to the horse buyer, in many cases, and even though mares were held, breeding has been neglected. The ebb flow of the ocean is just upon us.

It takes a very strongly anchored person to stand against the flow of tide. It is also usually a rather thankless job to advise going against any popular or well-nigh universal practice or habit. But there is always a tomorrow to be considered.

To illustrate the way the draft horse business is going, a short review of the history of the last several years in Tazewell County, Illinois, can be cited. Tazewell County has earned the fame of having more purebred Percheron horses per square mile of area than any other county in America. Old Louis Napoleon made history for the county in early days, and the draft horse interests have always been very large in the county. To obtain an accurate opinion as to the decrease in breeding in Tazewell County, the Tazewell County Percheron Association a short time ago canvassed the men owning stallions for the years 1915, 1916, 1917 and 1918. Direct questions were asked of each stallion owner as to the number of mares bred per stallion during these years. Enough replies were obtained to furnish reliable estimates. In 1915 there were recorded 155 stallions for public service. The average number of mares bred per stallion was 65. Counting a 50 per cent colt crop, there should have been 5,036 colts of the 1916 crop. In 1916 the number of registered stallions decreased to 140 and the average number of mares per horse also decreased to 55. This would be 3,850 colts for 1917. In 1917, the stallions again dropped to 115 and mares per stallion to 45½. According to this only 2,616 colts could be expected in 1918. Last year, 1918, the stallions only numbered 88, and the owners reported an average of 41 mares per stallion. This year we can expect about 1,800 colts. From 1915 to 1918 the stallions decreased from 155 to 88. The number of colts decreased from 5,036 to 1,800, or almost 180 per cent. Here is food for thought. If one of the big draft horse counties cuts down its horse production in this manner, what is going to happen to the supply of horses for market three and four years from now?

A like decrease can be seen in the decrease in stallions registered in the entire state. In 1912 there were 9,677 purebred and grade stallions licensed to stand at public service. In 1918, there were 7,120, or a decrease of 36 per cent.

The result is already becoming apparent in Tazewell County. The other day, the secretary of the County Percheron Association was trying to find some real geldings to price to a buyer. In the course of his search, a considerable number of men were consulted. No one knew of any big sound geldings of market age. A buyer of express horses told the secretary, a short time ago, that he was finding it very hard to find any horses suitable for his trade. Last August, in response to an inquiry for grade mares to over 50 men in Tazewell County, only 29 mares for sale were located.

In the light of these figures and from recent history, it begins to appear that there will be practically no horses soon. When that happens what will we do for work stock? And we will need work horses three, five, ten years from now.—CHESTER G. STARR, *Farm Adviser of Tazewell County, Ill.*

A BOOK ON THE SEXUAL QUESTION

MEN in Europe have often tried to bolster up a claim of superiority for their sex by pointing out that the perpetuation of the nation depended on its army and that they, by their compulsory military service, recognized and fulfilled the supreme obligation.

"But," the women have answered, "it is we who bear these men that thus defend the fatherland." Therefore they have claimed at least the equality of their sex.

Dr. Edward Toulouse, in his system of eugenics, proposes to take them at their word.

Every able-bodied woman, at the age of thirty, will be conscripted "to work, near her own home, for a certain number of hours daily, in a workshop, office or military hospital, in order to make available for actual military service all the soldiers who are commonly drawn off for non-combatant operations.

"The mother with three children will be exempt from this obligation; she who has two will do only six months of service; the mother of one child will serve for a year, and the childless woman two years."

"In this way woman will be pushed toward maternity by a force with a different compulsion than that of taxation. Obliged to perform a service that is noble, beautiful, equitable, but in practice disagreeable, or to bear children she will be naturally led to seek maternity. And in doing this she will not fear putting herself into a position of inferiority, for from the social as from the military point of view, procreation is more useful than an auxiliary service in the army. Similarly the husbands will rather make their wives mothers than send them into military service for two years. This method of preventing depopulation will be efficacious; and it will be only justice to make it serve the military interests of the state, which are particularly endangered by race-suicide."

A thorough-going proposal, is it not? French men of science are famous for the relentless clarity with which they push their arguments to logical conclusions, and Dr. Toulouse, in his book on social hygiene,[1] does not balk at any intermediate obstacles.

To enable this increase in maternity, financial means of caring for the children must be provided; but as children are in the last analysis the sole wealth of the state, Dr. Toulouse sees no reason why the state should hesitate to invest its funds in such good interest-bearing securities. He would have the expense of the early care and education of all children borne by the state if the parents required it; making no distinction between those of legitimate and illegitimate parentage.

But quality as well as quantity is necessary in a population, as the author does not fail to recognize; and he devotes a good deal of thought to finding the optimum compromise between these two contradictory demands. He would have the marriage, or at least the parenthood, of two persons with the same inheritable defect prevented. In case only one of the parents is tainted, it would suffice that the other be warned of the fact, so that at least he or she would marry with open eyes. To aid in this work of restrictive eugenics, he would have a "eugenics registry" maintained by the state, where all families would be described.

In this connection occur the principal errors of fact in a remarkable book. The author's views on "racial poisons"

[1] La Question Sexuelle et La Femme, par Docteur Toulouse. Pp. 288, prix f. 3.50. Paris: Bibliotheque-Charpentier, 11, Rue de Grenelle, 1918. Dr. Toulouse is medical director of the Villejuif Insane Asylum and one of the best known of French psychiatrists.

and the effect of disease on the germplasm are not supported by any evidence and must be considered as highly exaggerated.[2]

But it would be a mistake to think that the book as a whole is marked by these exaggerations. There have been few published discussions of social hygiene that are so sane, temperate, and national. Dr. Toulouse examines the many questions—the single standard of morality, free love, divorce, the proper age for marriage, monogamy and polygamy, illegitimacy, abortion, the position of women in industry—without dogma or sentiment, and always with a view to determining what solution will be most eugenic. In many ways his discussion is in advance of the current social hygiene literature of the United States, for in discussing such a question as the single standard he does not limit himself to arguments based on the fear of venereal infection and illegitimate parentage, as is too often done, but inquires into the philosophical bases on which chastity may be justified.

On the whole, the work is stimulating by the ideas it puts forth rather than by its presentation of any mass of data; for these are largely lacking. But few recent works on eugenics will better repay reading than this little volume by Dr. Toulouse.

All-Northwest Egg-Laying Contest

The egg-laying contest is a testing place for the poultry breeders of the state, and is also a testing place for those poultry raisers who want to improve their flock production. The contest, just closed, has clearly demonstrated that high egg production can be had from birds irrespective of altitude or other climatic conditions. The birds in the Second All-Northwest Contest came from places varying widely in all climatic conditions, as well as in available feeds. The high hen in the contest was a Single Comb White Leghorn, Number 251, which was bred, and is now owned by D. Tancred, of Kent, Washington. This bird laid 311 eggs during a period of 365 days. It is also a noteworthy fact that these birds made their records while kept in flocks of 36. The usual number of birds in other contests are from five to ten birds. It is more credit to a breeder to have a high record in a large flock than in a small one.

During the past seven years the poultry raisers have become more interested in the egg-laying contests. Men who are doing good breeding work are anxious to have their birds tested in order that they may have official records of their production. Egg-laying contests have brought clearly before the poultry public that in order to have birds that would produce eggs, it would be necessary to have good breeding back of the birds. Feed is, to be sure, an important factor in egg production, but it is necessary to have birds which are able to handle feed and convert it into eggs before high records can be made either at home or at the contests. The poultrymen who enter their birds in the egg-laying contests, year after year, show a marked improvement in the quality of their stock. A few years ago the average poultryman or farmer was rather skeptical about a bird having the ability to lay 200 eggs in one year. The official trap-nesting done during the past few years has demonstrated that a good percentage of birds entered lay in the neighborhood of 200 eggs in a year. About 5% of the birds at the Second All-Northwest Egg-Laying Contest laid over 250 eggs each, while 31% of the birds laid over 200 eggs, and 71% over 150 eggs.—R. V. Mitchell, *Director, Washington Agricultural Experiment Station, Pullman, Washington.*

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[2] On pages 47–48 Dr. Toulouse expresses a doubtful belief in the superstition of telegony, which is now thoroughly discredited among geneticists.

A Pioneer Research in Correlation

DISTRIBUTION BY SCHOOL GRADES OF THE WEIGHTS OF BOYS AGED 9 [1]

Grades (pounds)	Mentally inferior			Mentally superior	
	I	II	III	IV	V
78	.....	4	.....	.....	.....
77	.....	1	4	.....	.....
76	.....	5	3	1	.....
75	.....	1	1	1	.....
74	1	5	2	.....	1
73	1	7	4	.....	.....
72	3	5	4	1	.....
71	3	6	4	2	.....
70	7	16	6	1	.....
69	5	10	6	1	.....
68	1	17	6	.....	.....
67	1	21	10	2	.....
66	3	29	8	2	.....
65	11	22	14	3	1
64	21	53	18	2	.....
63	17	44	22	4	.....
62	25	63	13	.....	.....
61	25	54	23	4	.....
60	29	72	21	3	.....
59	29	61	16	2	.....
58	27	74	23	3	.....
57	37	65	17	1	.....
56	33	62	14	1	.....
55	39	91	21	3	1
54	30	72	18	2	.....
53	39	78	10	.....	.....
52	33	52	18	1	.....
51	28	50	14	.....	.....
50	25	48	10	1	.....
49	20	28	6	1	.....
48	14	24	4	.....	.....
47	19	14	1	1	.....
46	8	8	.....	.....	.....
45	13	11	1	.....	.....
44	7	7	3	.....	.....

[1] A few scattering figures relative to very heavy and very light boys are here omitted.

ALL GOOD QUALITIES ARE CORRELATED

As far as known, all good qualities are correlated—that is, persons who are superior in one direction are likely to be superior in every other direction, exceptions to the contrary notwithstanding. This law is so important in eugenics and so completely in conflict with popular belief that insistence upon its truth is much needed. The above table, which proves that bright children weigh more than dull children, is reproduced from the transactions of the Academy of Science of St. Louis, March, 1893. It is the first table in a research made by Dr. William Townsend Porter on growing school children. The black lines near the center mark the averages and it can be seen that these rise like a perfect flight of stairs. All the boys were nine years old, but superior mentality was found correlated with physical development. A successive series of grades like the above is always a true test of a correlation. A further discussion of correlations within the individual and their relations to eugenics appeared in the JOURNAL OF HEREDITY for February, 1919.